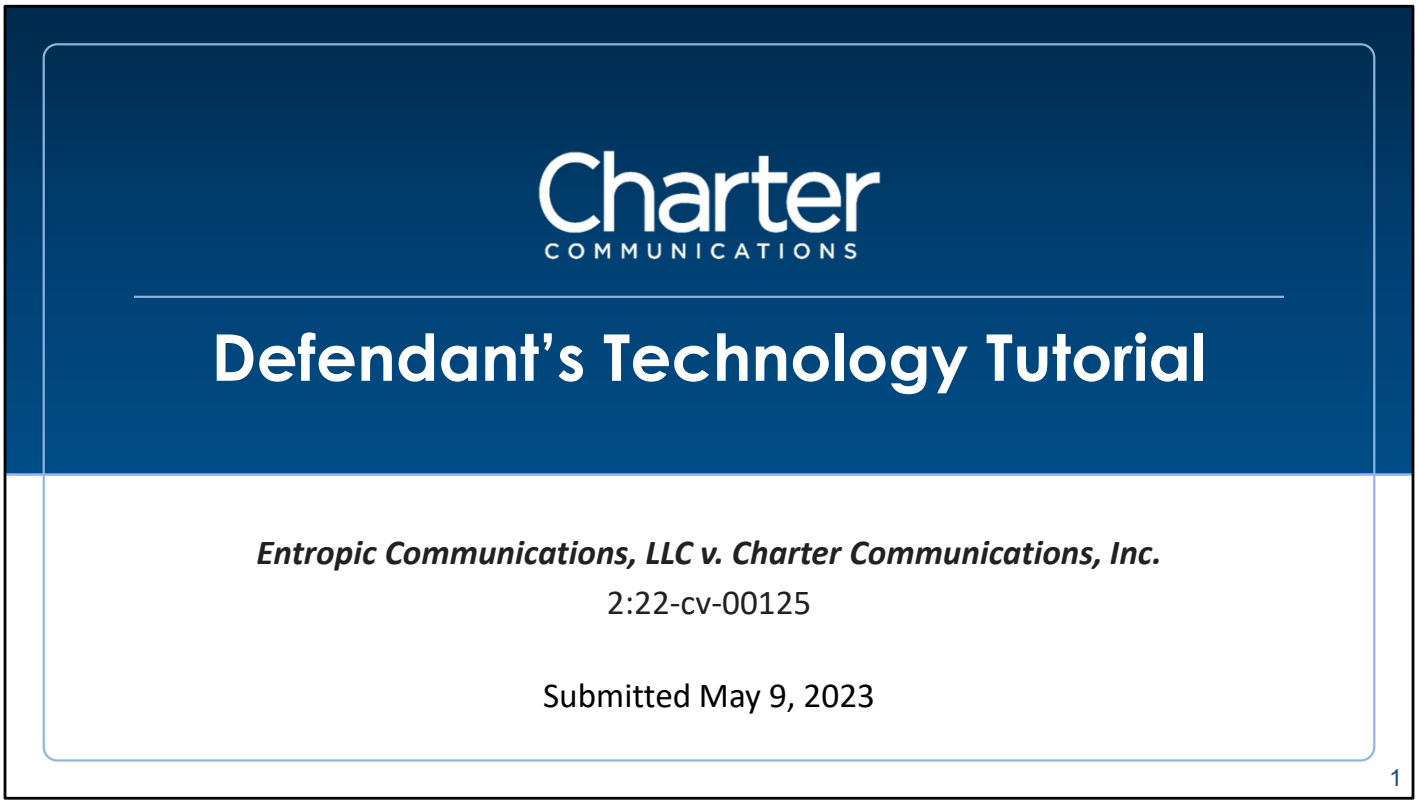
EXHIBIT 1



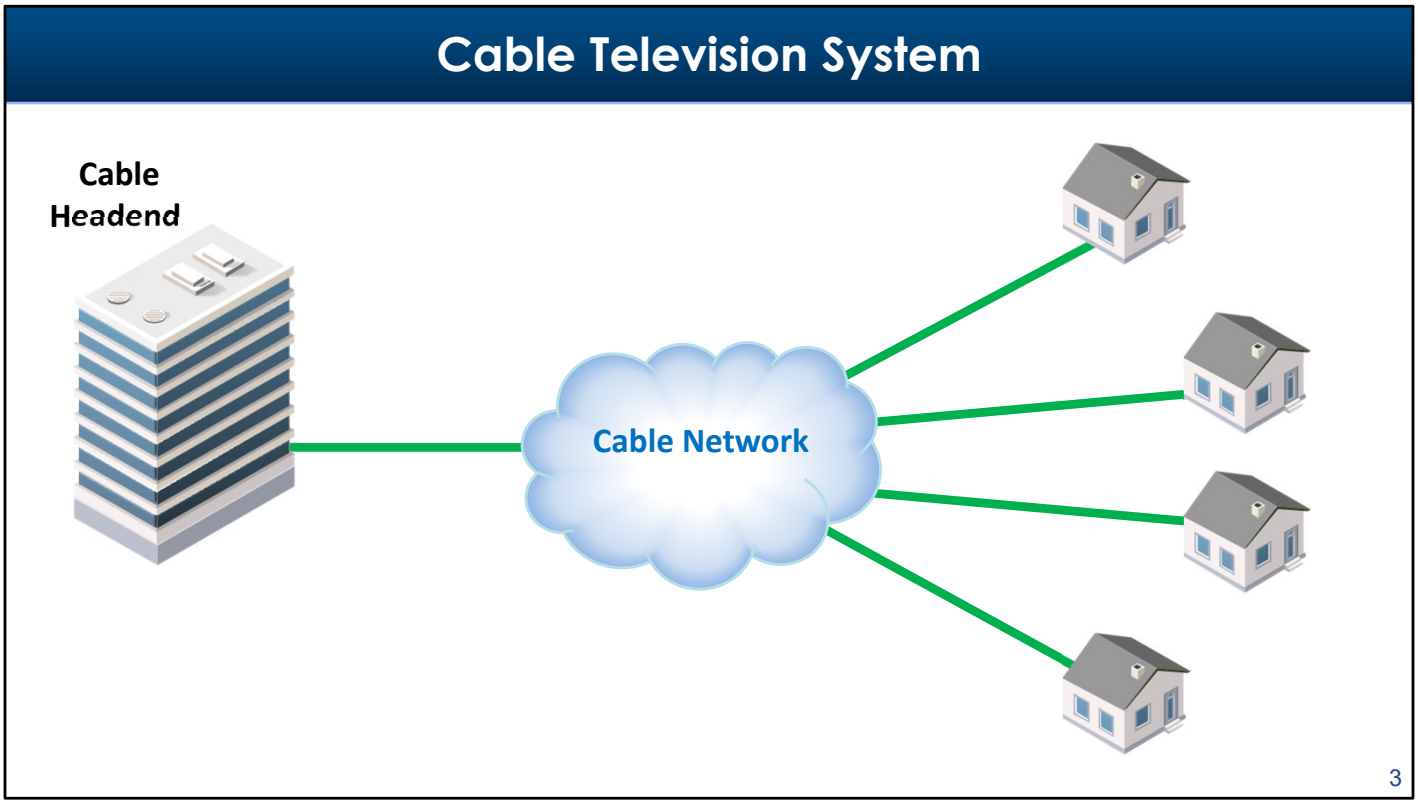
Good day Your Honor. This is Defendant Charter Communications' technology tutorial in the patent infringement action brought by Entropic Communications, case number 2:22-cv-00125.

Cable Television Systems

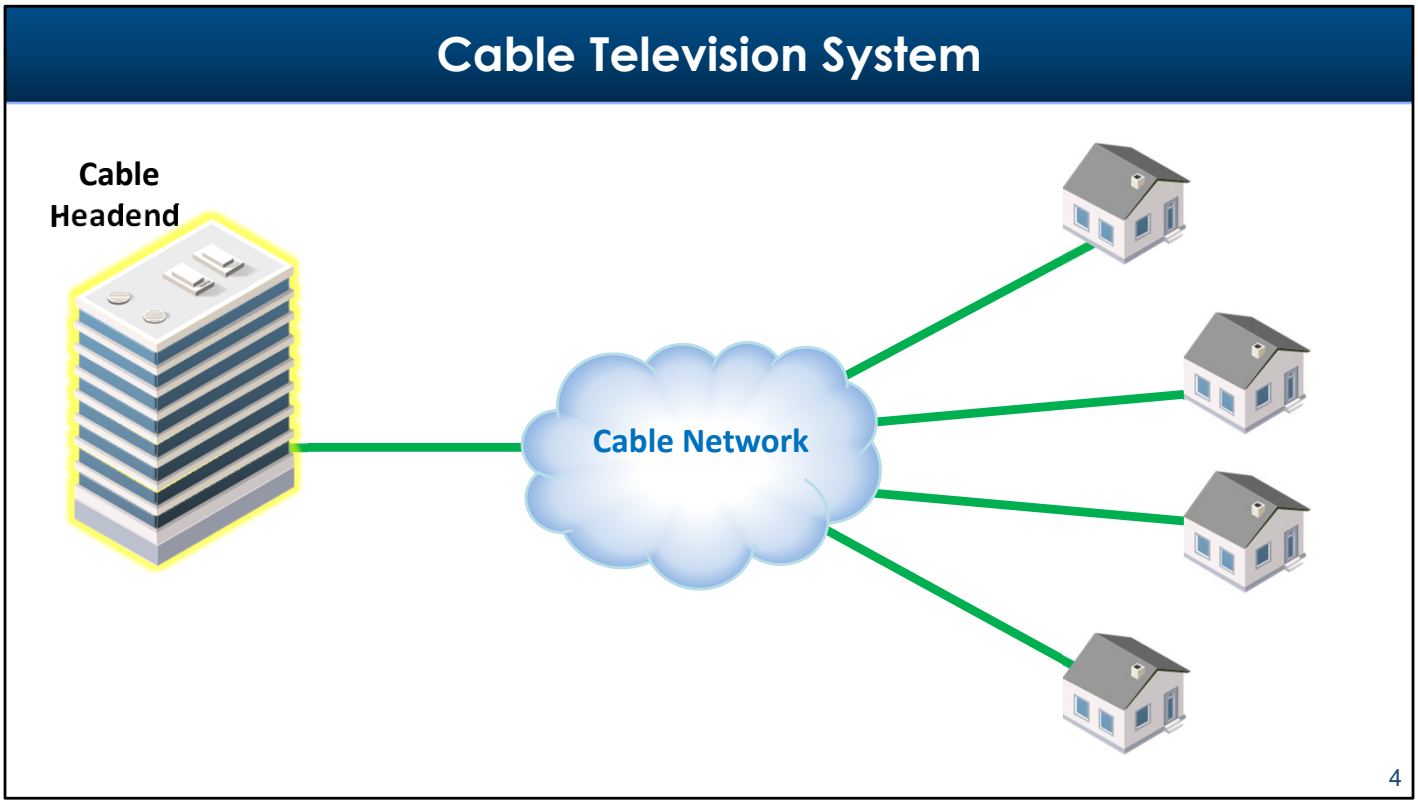
2

The patents at issue in this case are alleged to relate to cable television systems.

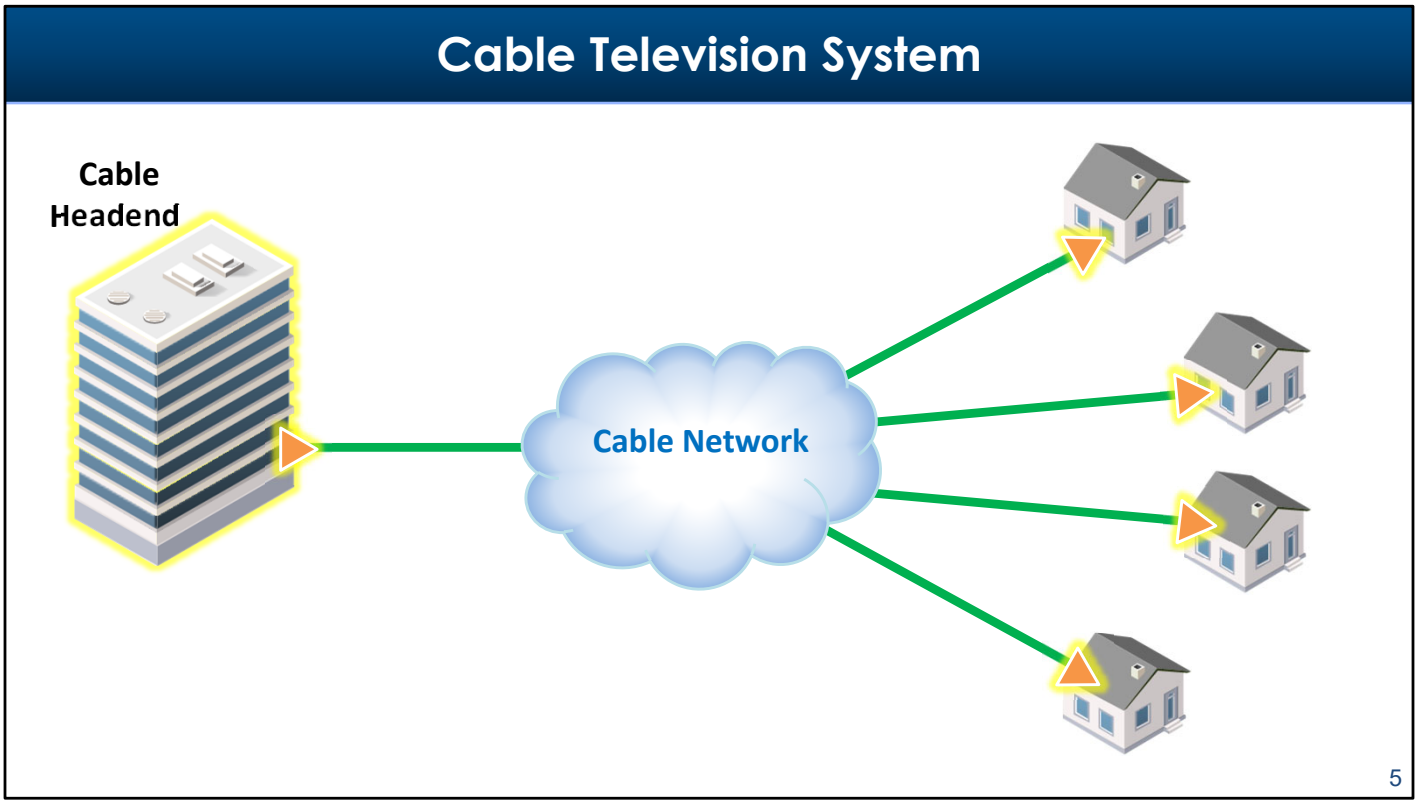
So we'll begin this tutorial with a brief overview of cable TV systems, after which we'll look at the patents.



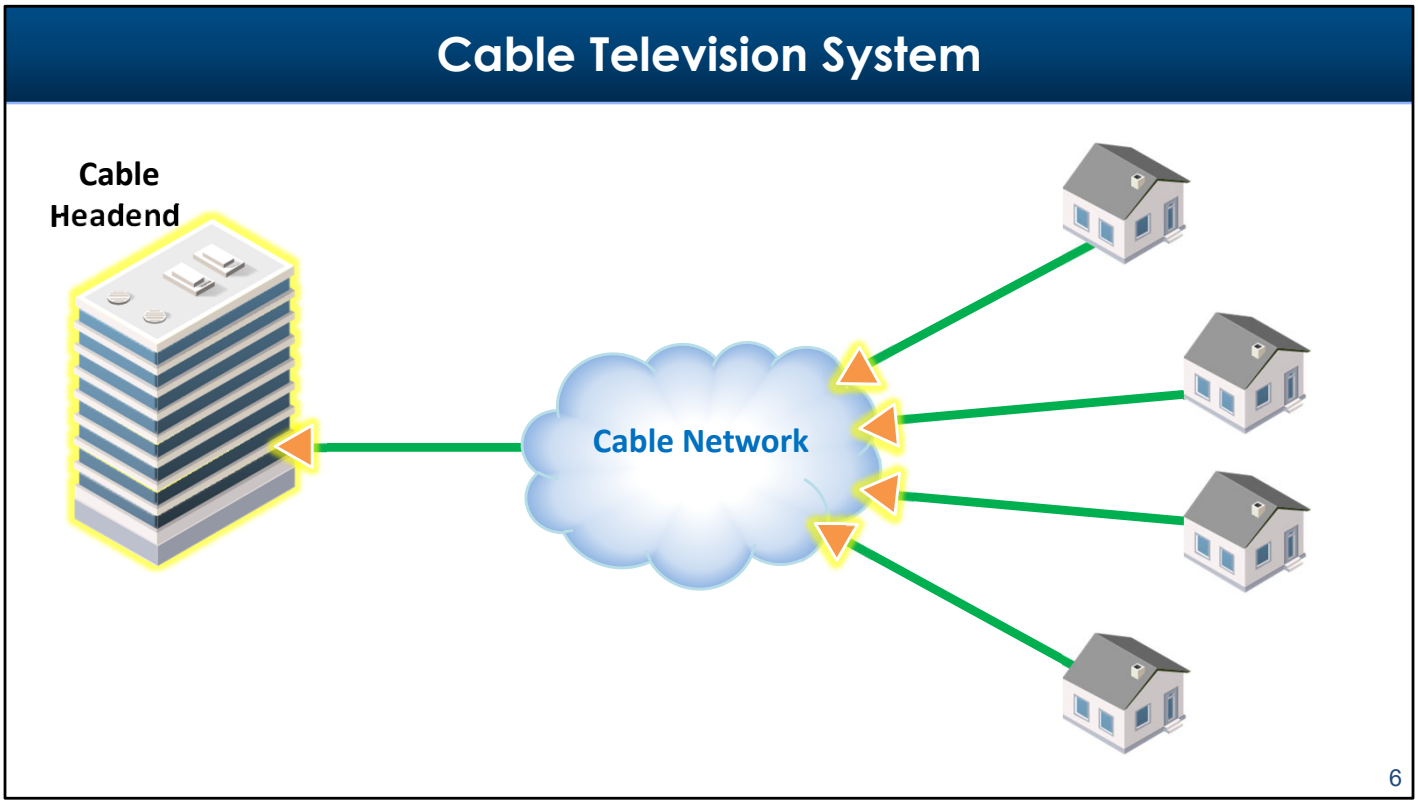
This figure is a simplified depiction of a cable television system.



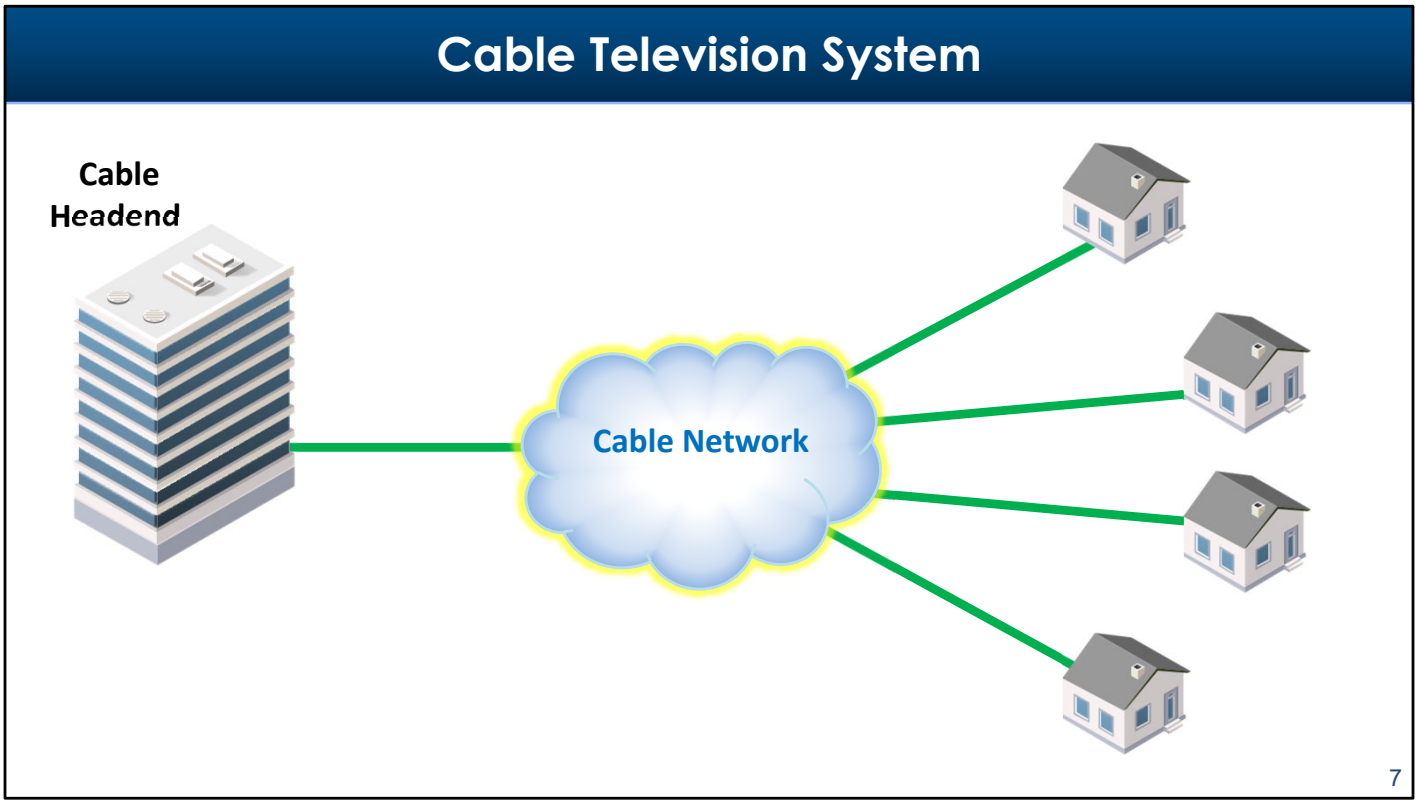
On the left we depict a Cable Headend.



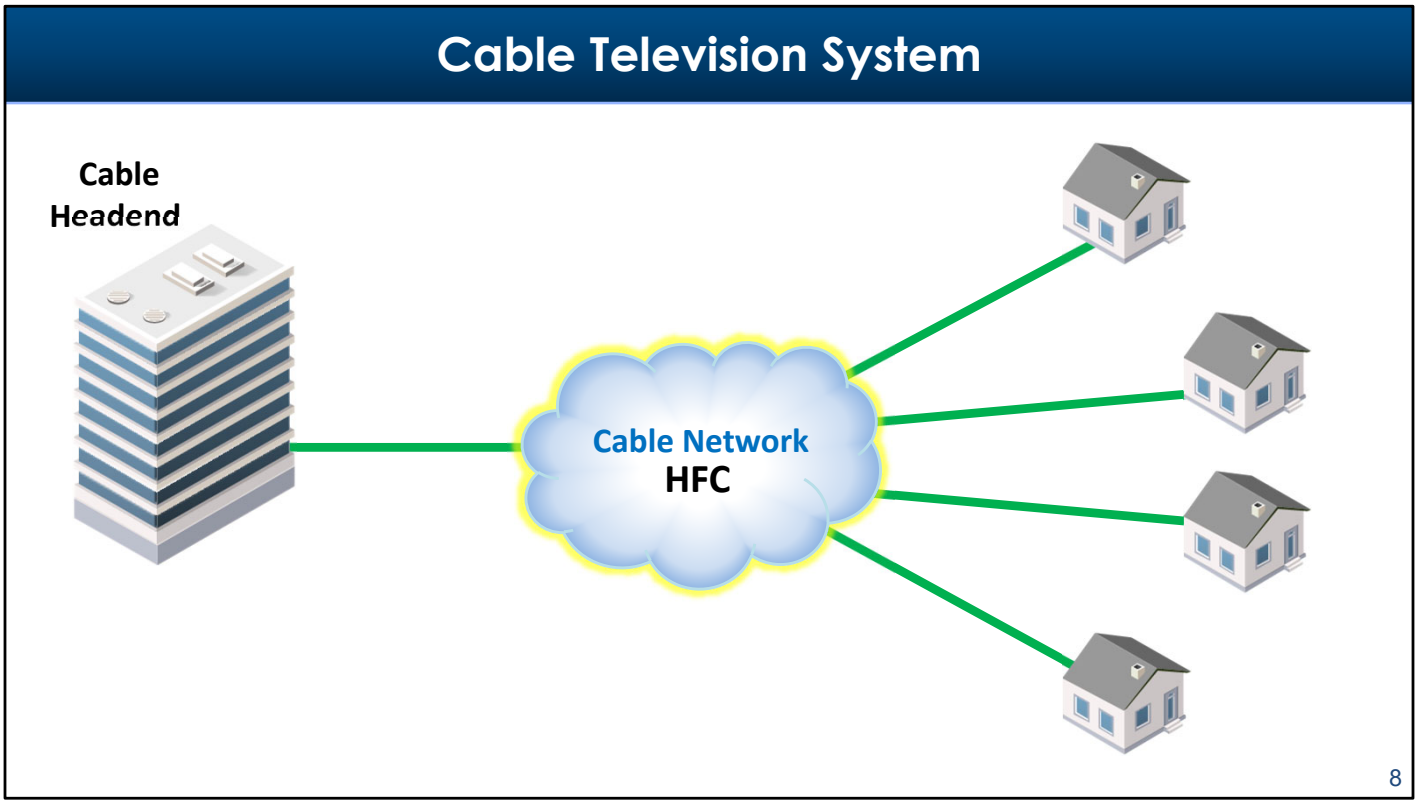
The headend contains equipment that sends television signals and data to customer homes.



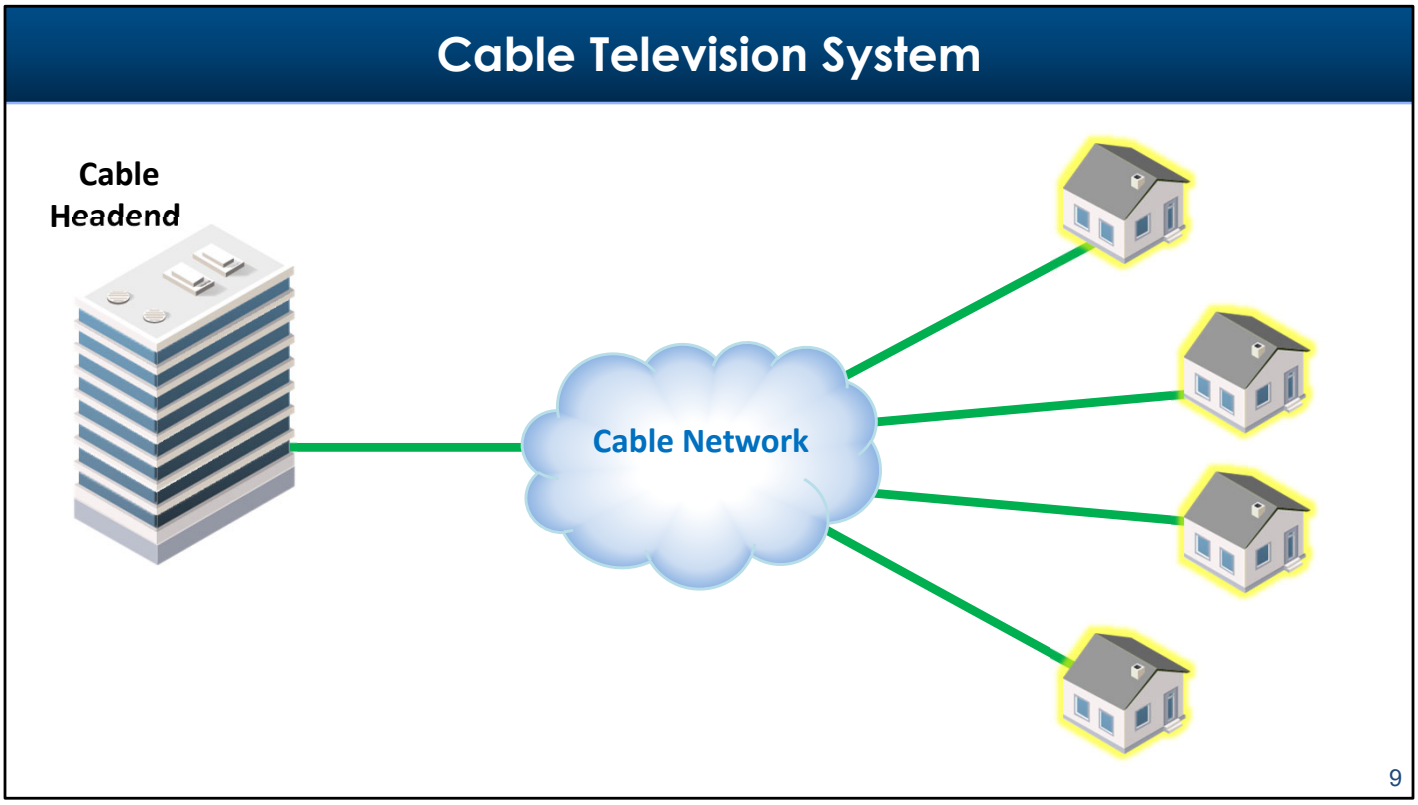
The headend also receives data from customer homes. For example, when customers order video on demand movies those requests can be sent to a cable headend.



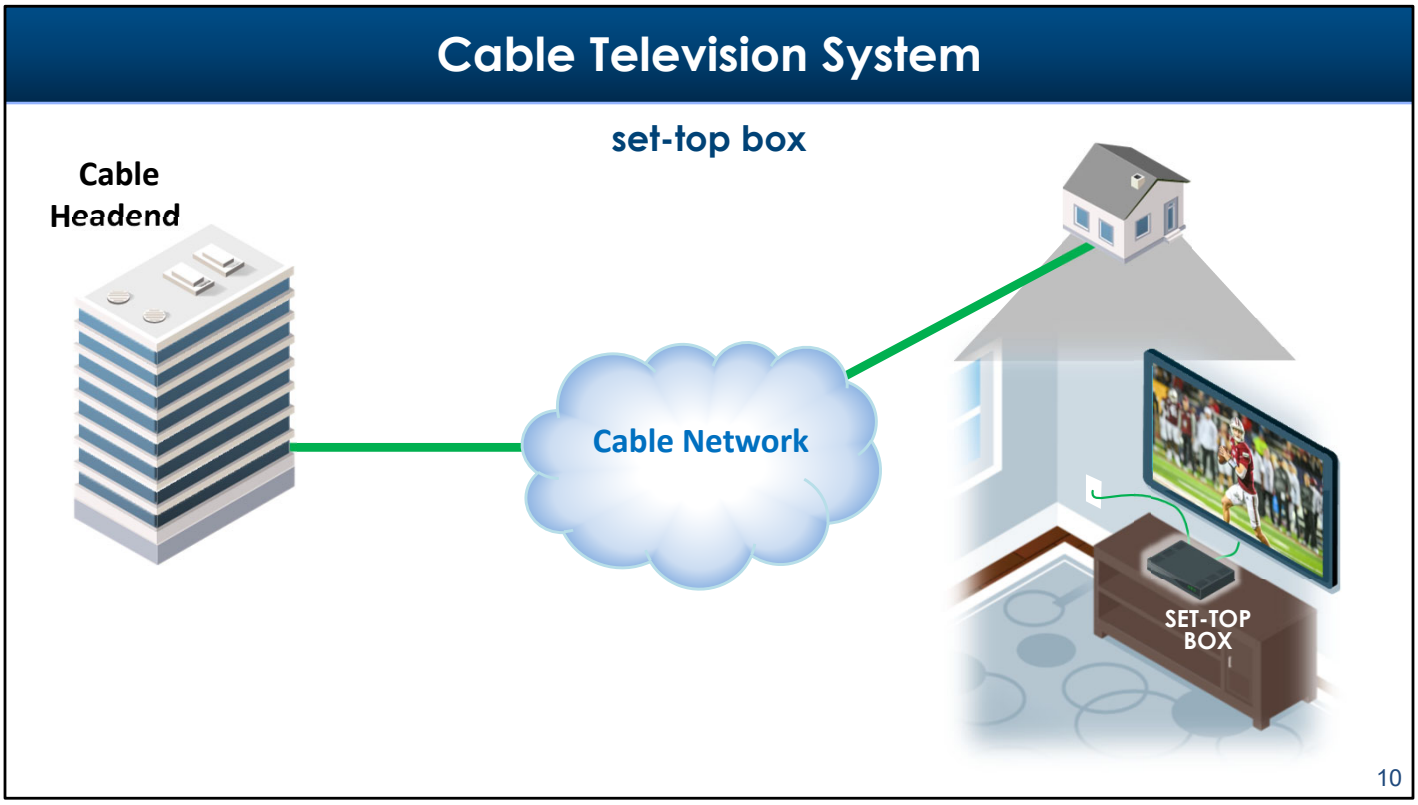
In the middle of the figure is the cable network, which connects the headend to customer homes.



The cable network can consist of both fiber optic cables and coaxial cables. Consequently, these networks are sometimes referred to as hybrid fiber-coax networks, or HFC networks for short.

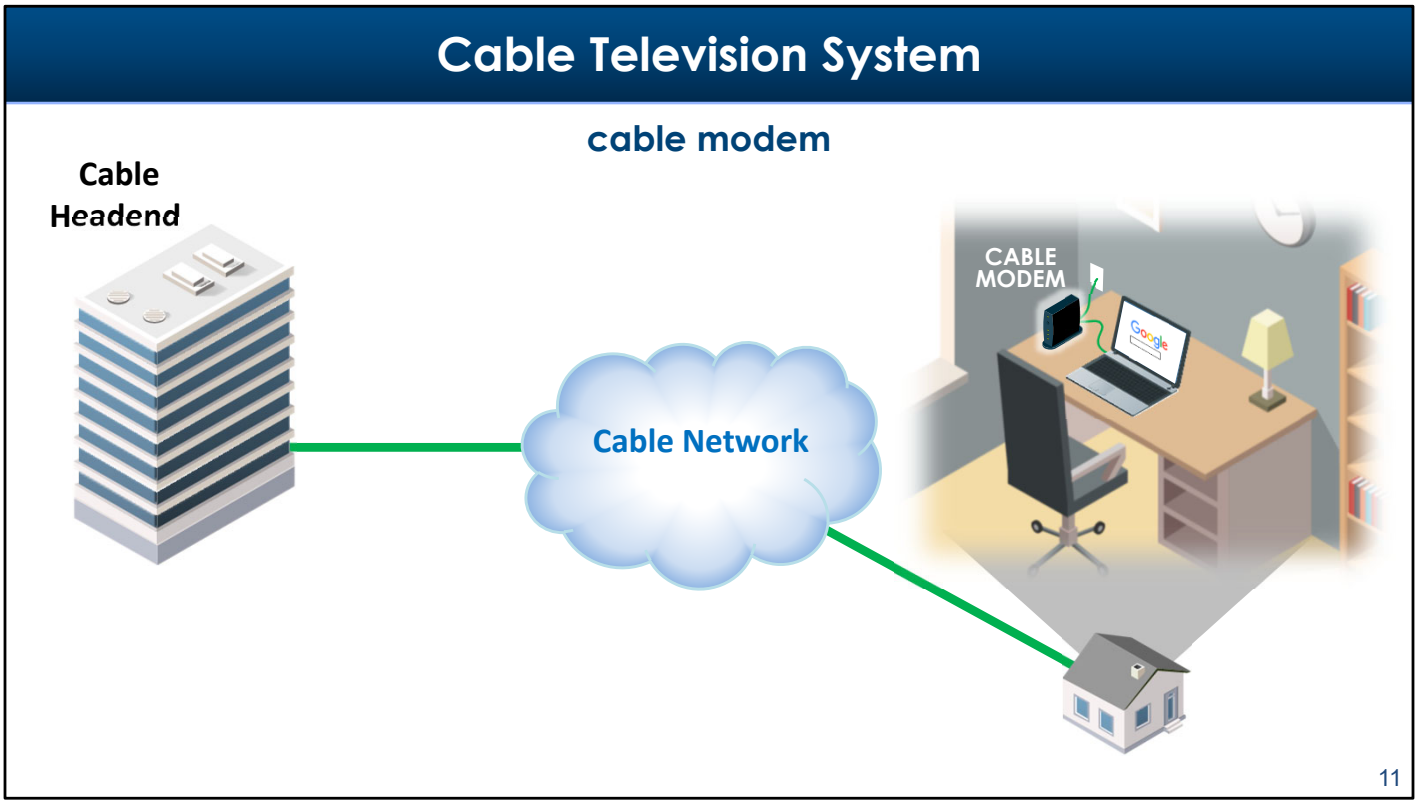


And finally, on the right side of the figure we show the customer homes.



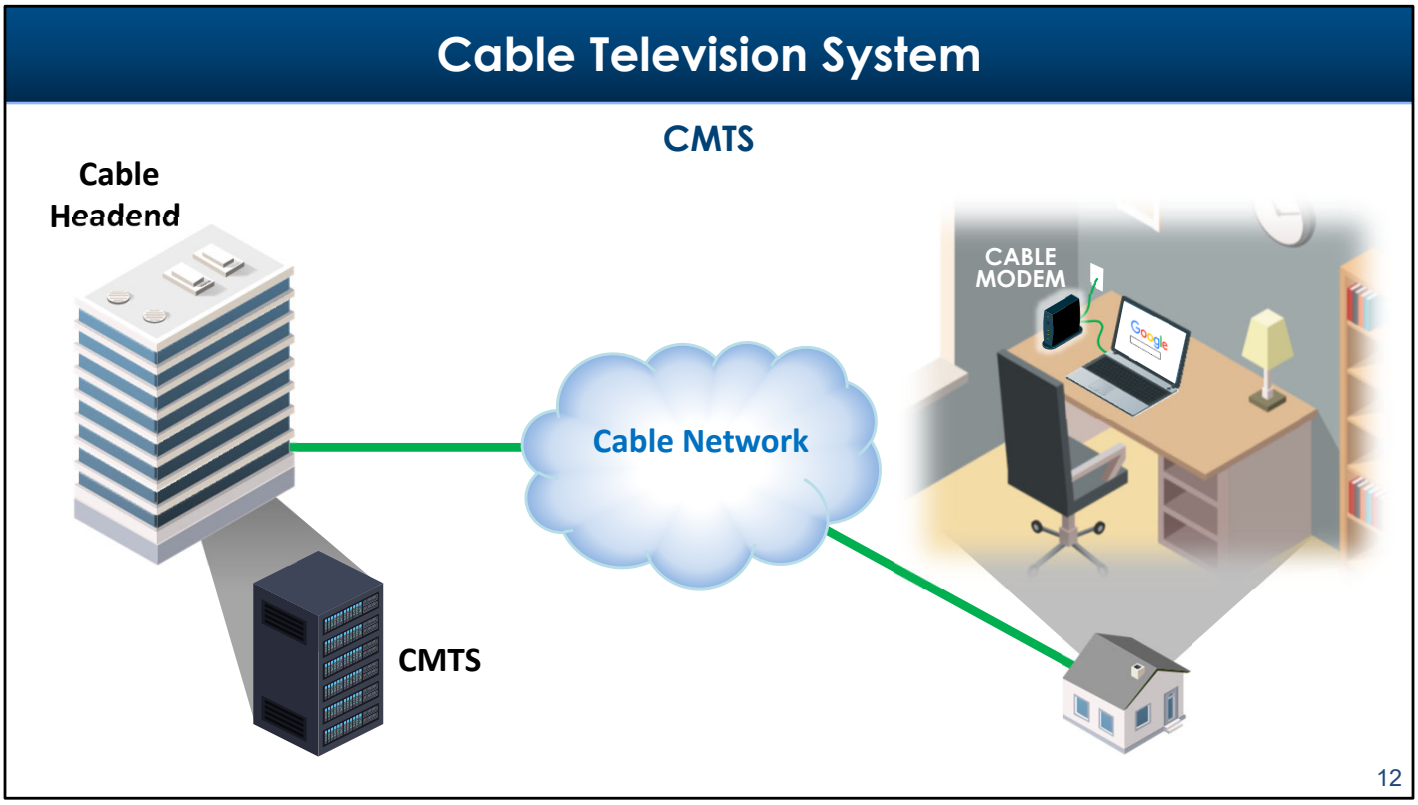
As Your Honor may know, cable companies provide different types of services to their customers. Obviously, one service cable television companies provide is television service. As shown on this slide, one way cable companies offer television service is through set-top boxes in customer homes.

A set top box receives television signals from the headend and displays them on the customer television. Here, we show the customer watching a football game.

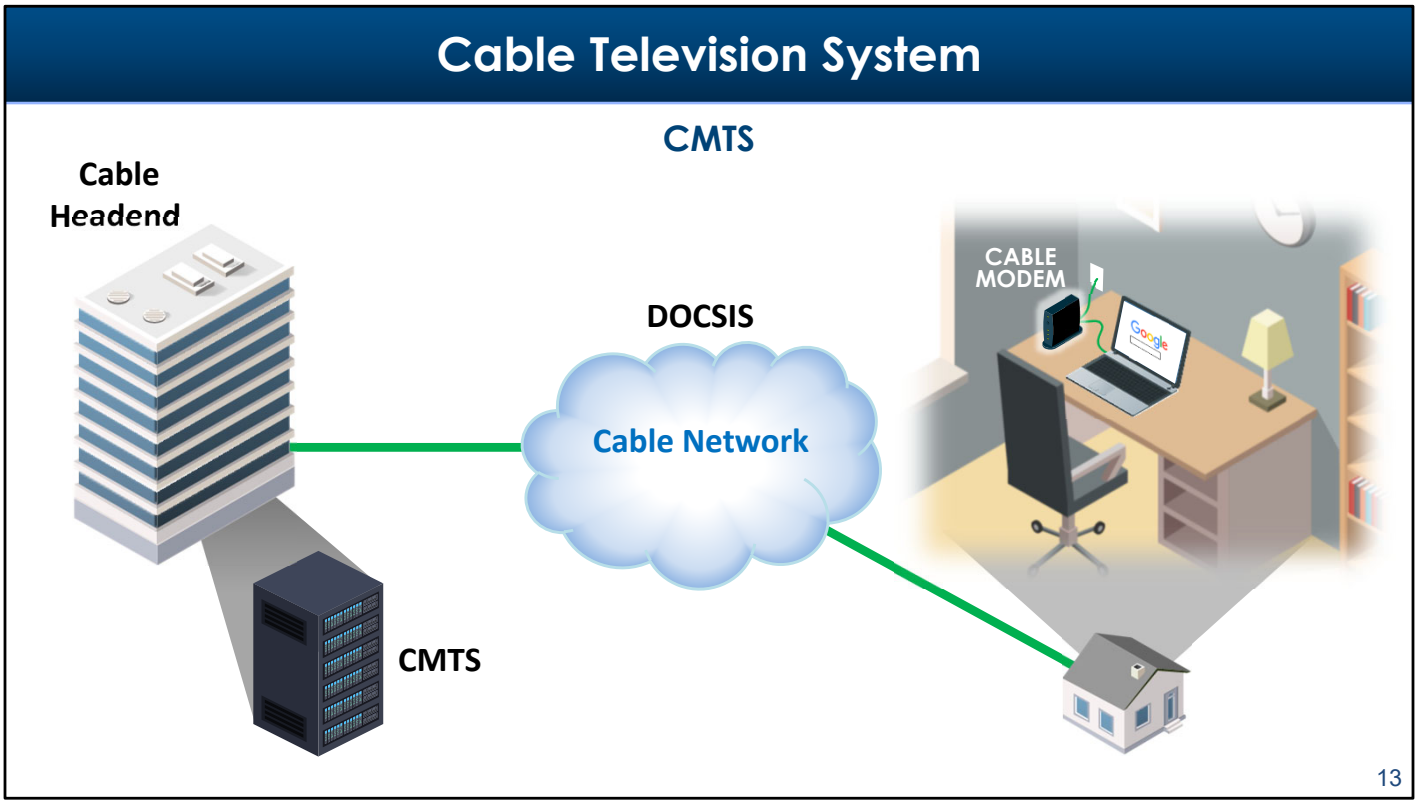


Cable companies today also provide data services to their customers, such as access to the Internet.

As shown here, one way that cable companies provide Internet access to customers is through cable modems in customer homes.



Those cable modems communicate with a device at the cable headend called a cable modem termination system, or CMTS.



That communication between the cable modems and the CMTS occurs pursuant to a cable industry communications standard called DOCSIS, which stands for Data Over Cable Service Interface Specification.

Asserted Patents

14

That concludes our overview of cable television systems.

We'll now turn to a discussion of the asserted patents.

6 Asserted Patents

15

There are 6 asserted patents in this case. Three of them are asserted against set-top boxes, and the other three against cable modems or CMTSs.

6 Asserted Patents

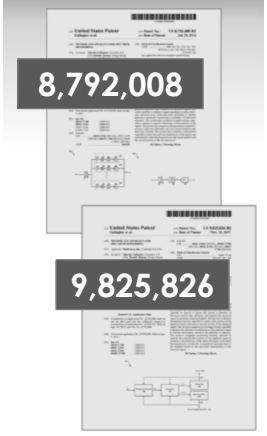
Spectrum Monitoring

16

The 008 and 826 patents are in the same patent family and share a common specification. These patents relate to spectrum monitoring of television signals, and are asserted against set-top boxes.

6 Asserted Patents

Spectrum Monitoring



Wideband Tuner Architecture

17

Next, the 362 patent discloses an allegedly novel architecture for a wideband tuner. This patent is also being asserted against set-top boxes.

6 Asserted Patents

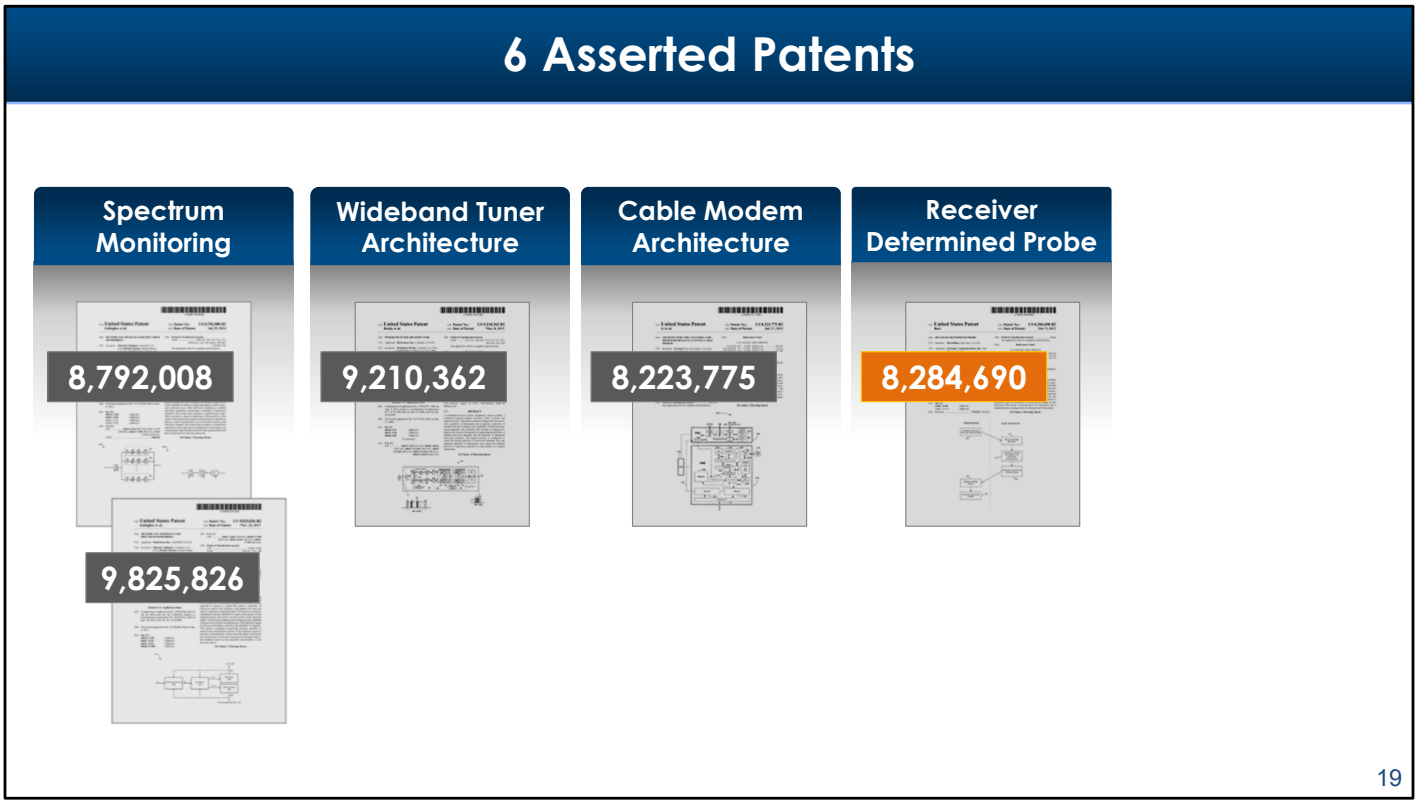
Spectrum Monitoring

Wideband Tuner Architecture

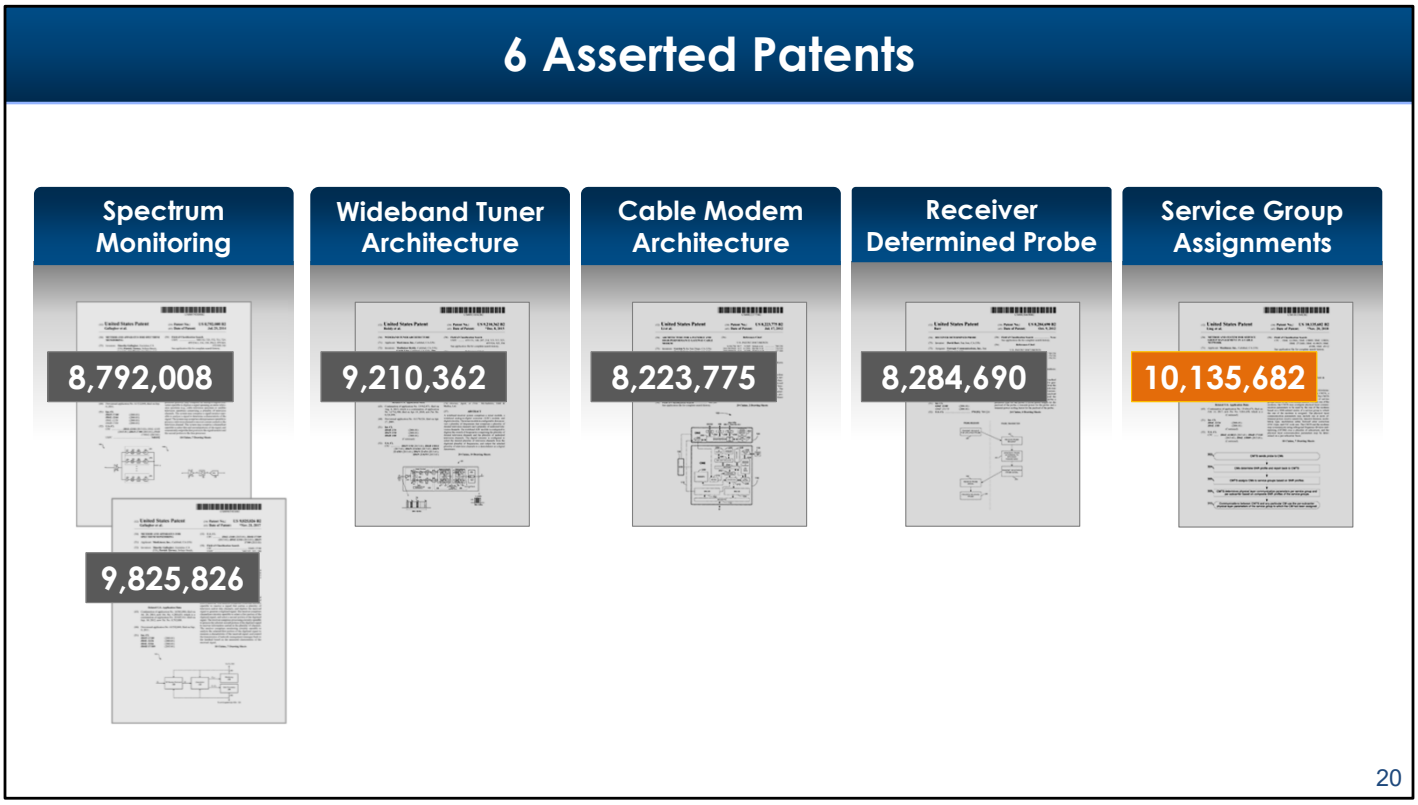
Cable Modem Architecture

18

The fourth patent is the 775 patent, which is directed to an allegedly novel cable modem architecture. This patent is being asserted against cable modems.



Next, the 690 patent is directed to a receiver determined probe. I'll explain what this means when I review the 690 patent. This patent is being asserted against cable modems and CMTSs.



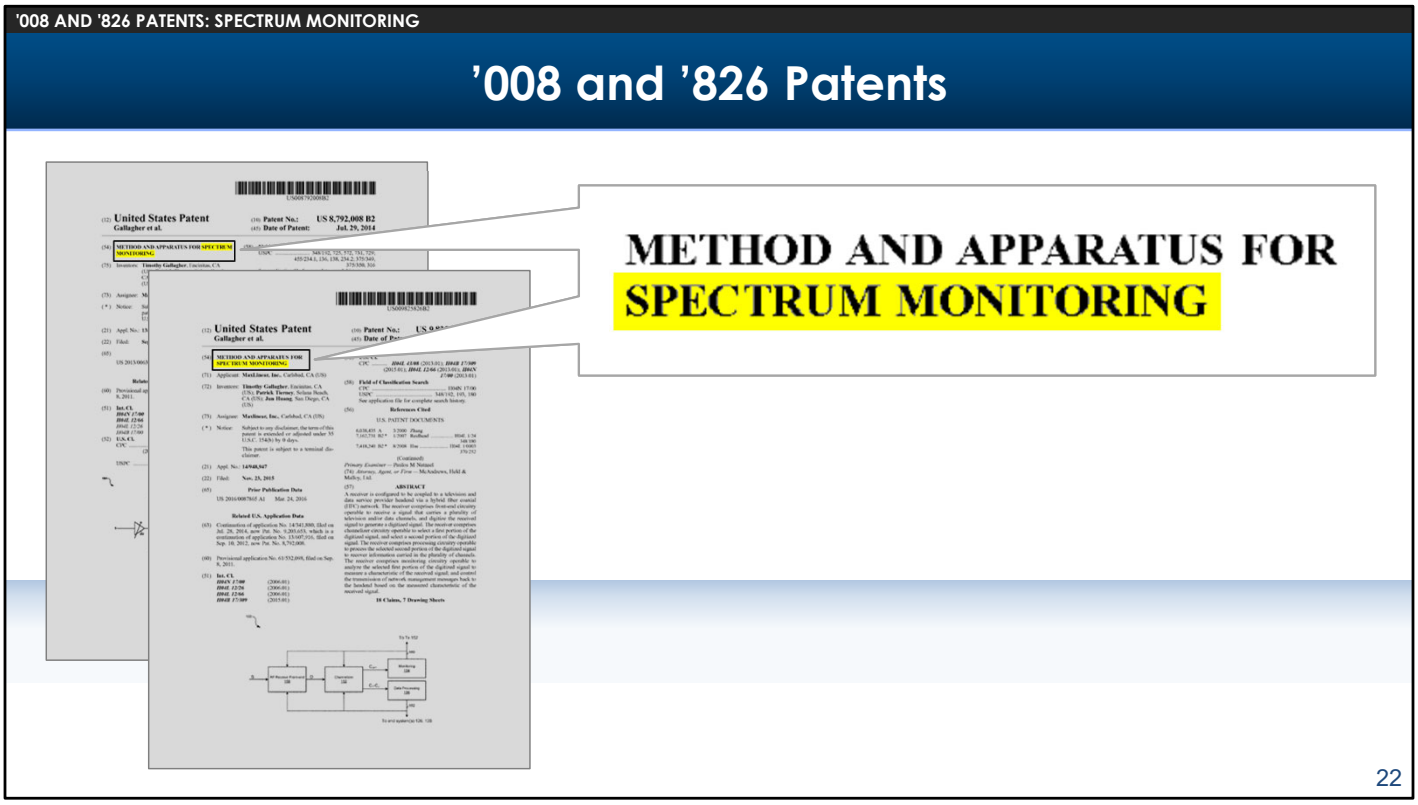
And finally, the 682 patent is directed to an allegedly novel way to assign cable modems to service groups. This patent is being asserted against CMTSs.

SPECTRUM MONITORING

’008 and ’826 Patents

21

I’ll begin my discussion of the patents with the 008 and 826 patents.

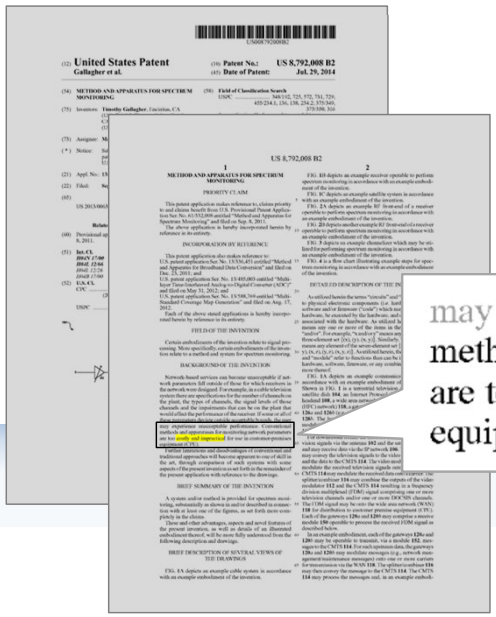


As their titles indicate, these patents relate to spectrum monitoring. The 008 patent relates to an allegedly novel architecture for a device that monitors cable television signals, and the 826 patent relates to the method by which that architecture operates.

As I mentioned earlier, the 008 and 826 patents are related and share a common specification.

'008 AND '826 PATENTS: SPECTRUM MONITORING

Problem To Be Solved



may experience unacceptable performance. Conventional methods and apparatuses for monitoring network parameters are too costly and impractical for use in customer-premises equipment (CPE).

'008 Patent, 1:42-45

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According to the patents, while spectrum monitoring of cable television signals was known, existing ways of doing it were too costly and impractical.

'008 AND '826 PATENTS: SPECTRUM MONITORING

Exemplary Cable System

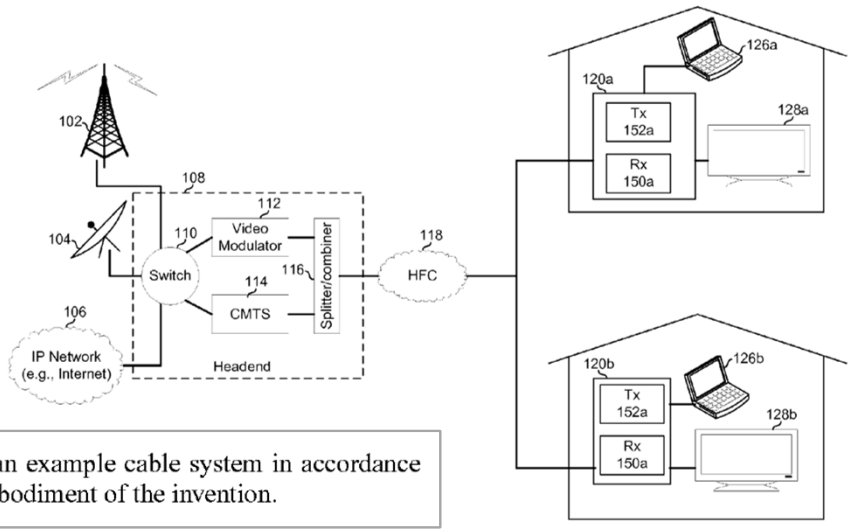


FIG. 1A depicts an example cable system in accordance with an example embodiment of the invention.

'008 Patent, 1:66-67

FIG. 1A

24

Figure 1A of the patent depicts an exemplary cable system in which the alleged invention would be used.

'008 AND '826 PATENTS: SPECTRUM MONITORING

Exemplary Cable System

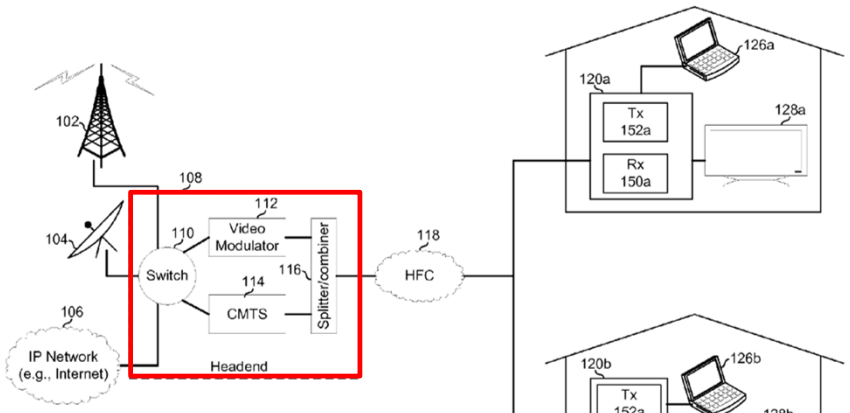


FIG. 1A depicts an example cable system in accordance with an example embodiment of the invention.

'008 Patent, 1:66-67

FIG. 1A

25

On the left, annotated in red, is the cable headend.

'008 AND '826 PATENTS: SPECTRUM MONITORING

Exemplary Cable System

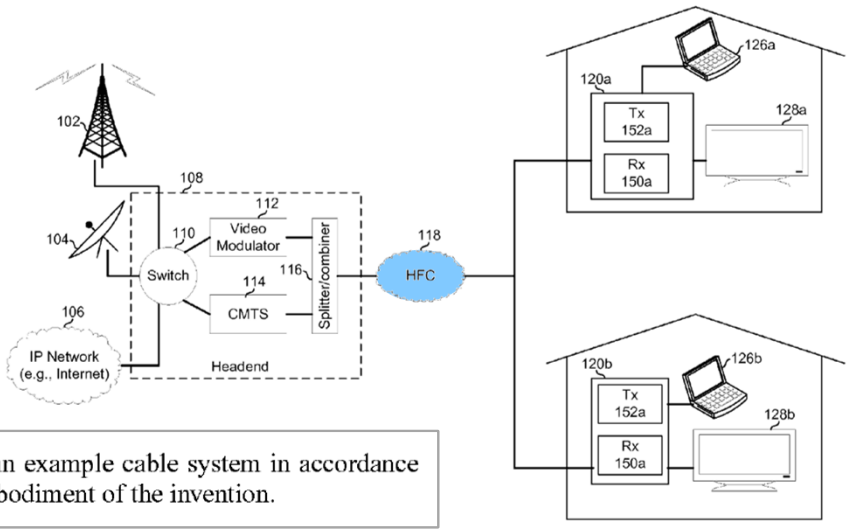


FIG. 1A depicts an example cable system in accordance with an example embodiment of the invention.

'008 Patent, 1:66-67

FIG. 1A

26

In the middle is the hybrid fiber/coax cable network annotated in blue.

'008 AND '826 PATENTS: SPECTRUM MONITORING

Exemplary Cable System

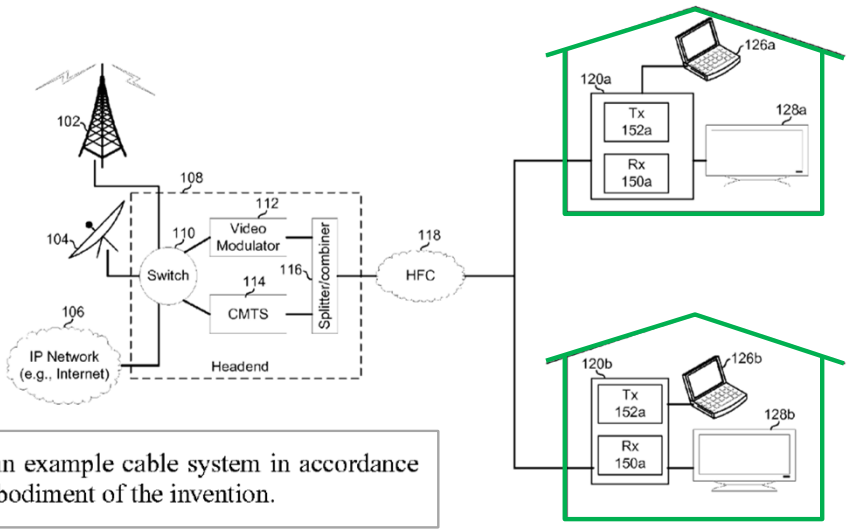


FIG. 1A depicts an example cable system in accordance with an example embodiment of the invention.

'008 Patent, 1:66-67

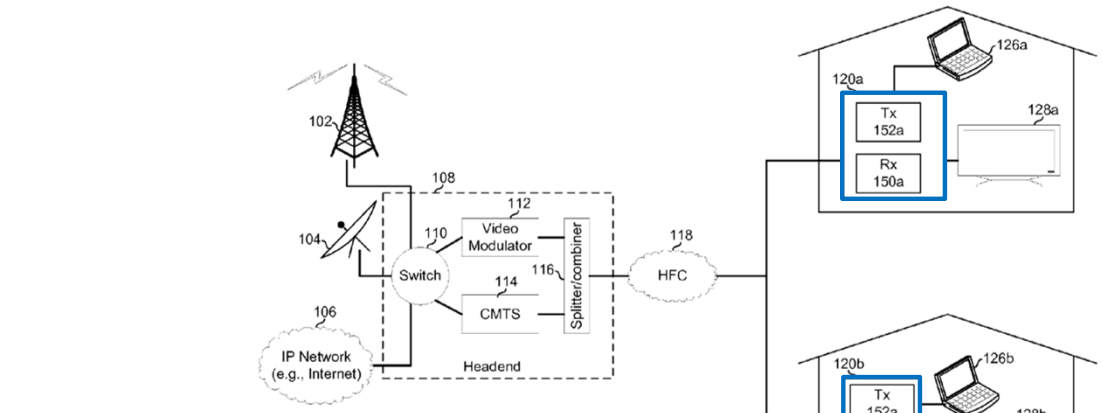
FIG. 1A

27

And on the right, annotated in green, are the customer homes.

'008 AND '826 PATENTS: SPECTRUM MONITORING

Gateway



(HFC) network) **118**, a gateways **120***a* and **120***b*, end systems

'008 Patent, 2:39

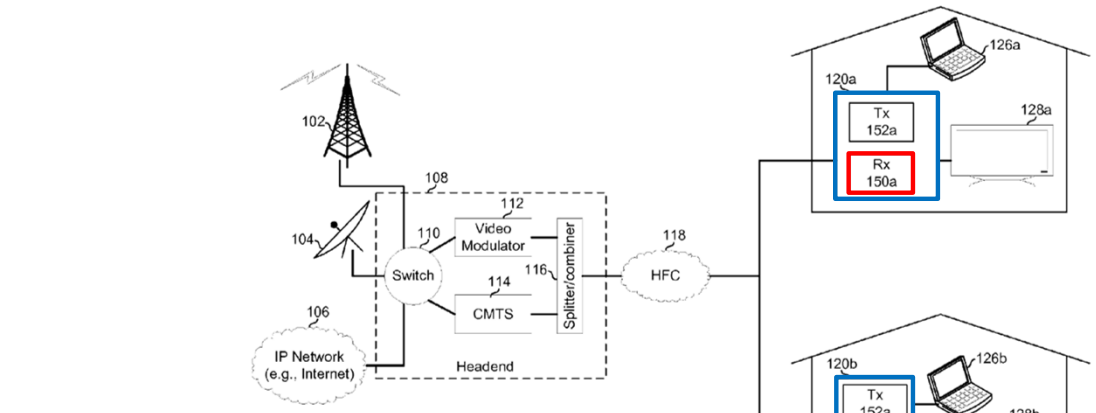
FIG. 1A

28

Within each of the customer homes is a gateway device, which we've outlined in blue. As you can see, within each gateway device is a transmit module T X and a receiver R X.

'008 AND '826 PATENTS: SPECTRUM MONITORING

Receiver



Each of the gateways **120***a* and **120***b* may comprise a receive module **150** operable to process the received FDM signal as described below.

'008 Patent, 2:57-59

FIG. 1A

29

The alleged invention relates to the receiver, which we've indicated in red. The receiver is the component of the gateway that receives and processes the signals from the headend.

'008 AND '826 PATENTS: SPECTRUM MONITORING

Receiver

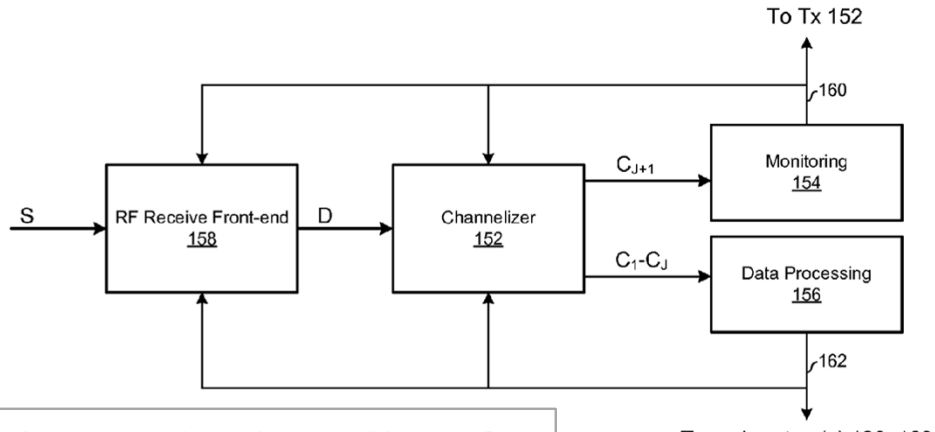


FIG. 1B depicts an example receiver operable to perform spectrum monitoring in accordance with an example embodiment of the invention. Shown in FIG. 1B is a receiver circuit

'008 Patent, 3:5-7

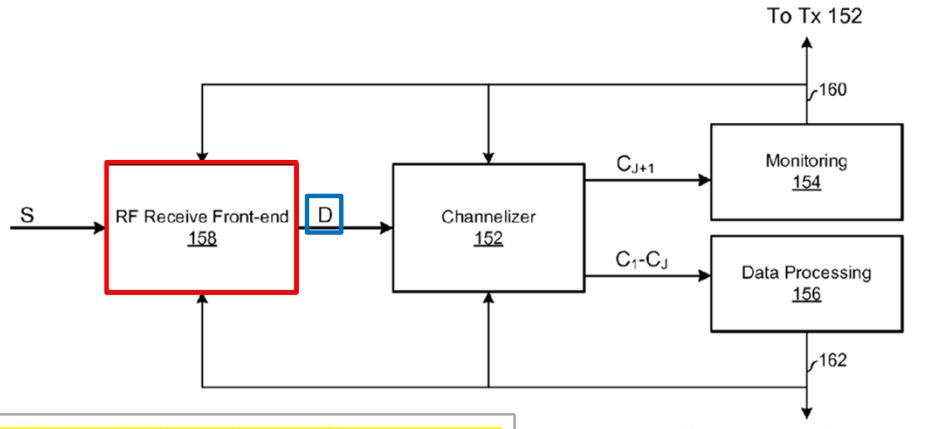
FIG. 1B

30

FIG. 1B depicts the allegedly novel architecture for the receiver.

'008 AND '826 PATENTS: SPECTRUM MONITORING

RF Receive Front-End



The RF receive front-end **158** may be operable to process a received RF signal S to generate a digital signal D. The signal

'008 Patent, 3:11-12

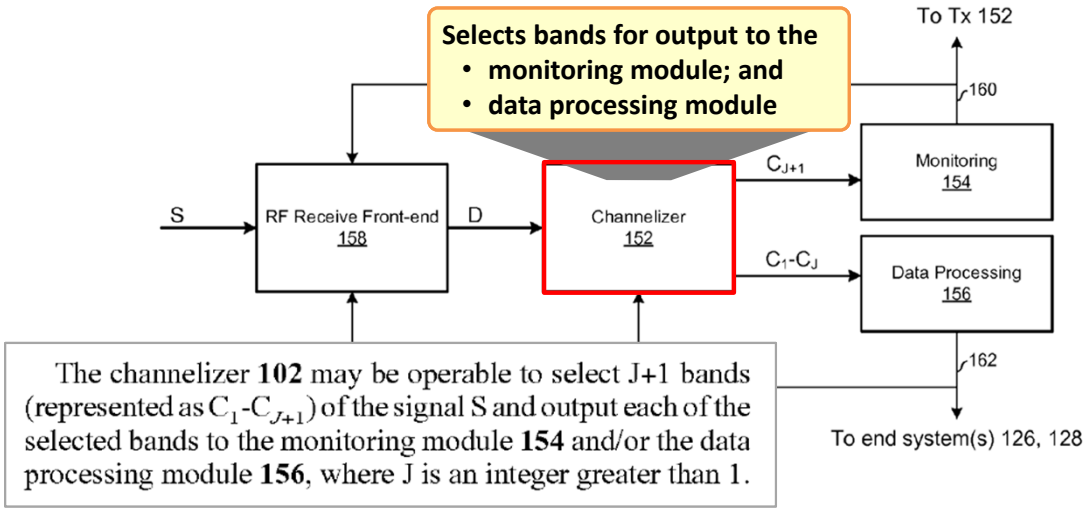
FIG. 1B

31

The receiver includes a so-called RF Receive Front end, which we've annotated in red. This converts the incoming signal from analog to digital form. We've annotated the digital output in blue.

'008 AND '826 PATENTS: SPECTRUM MONITORING

Channelizer



'008 Patent, 3:20-23

FIG. 1B

32

After the signal is digitized it is provided to a channelizer. The function of the channelizer is to select which of the received frequency bands to provide to the monitoring module 154 and which to provide to the data processing module 156.

'008 AND '826 PATENTS: SPECTRUM MONITORING

Channelizer

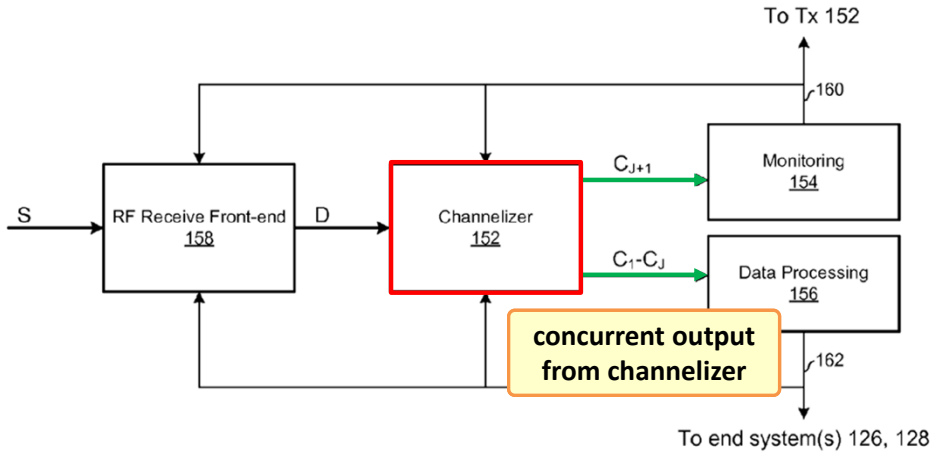


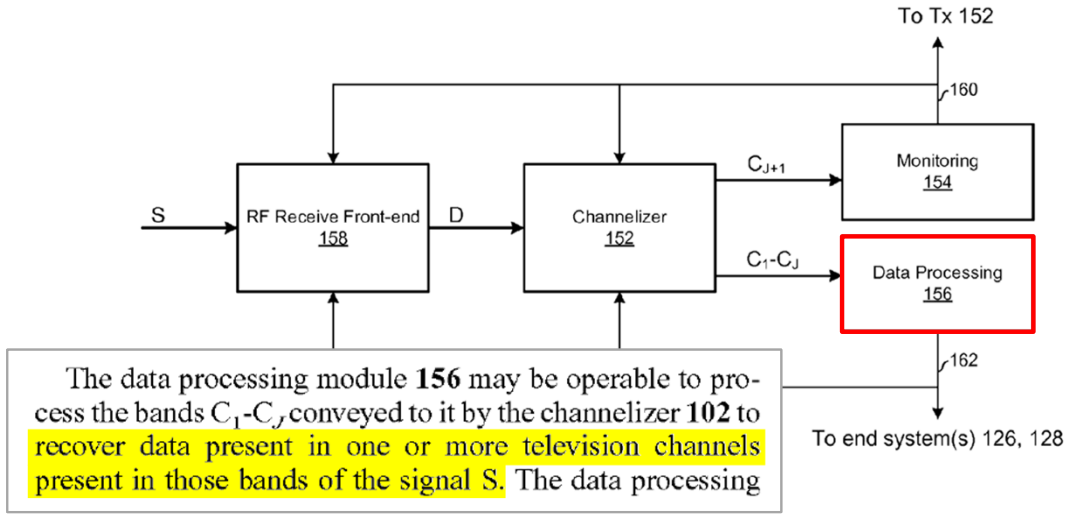
FIG. 1B

33

According to the claims, after the selection is made, the channelizer provides concurrent output to the monitoring module and the data processing module.

'008 AND '826 PATENTS: SPECTRUM MONITORING

Data Processing Module



The data processing module **156** may be operable to process the bands C_1-C_J conveyed to it by the channelizer **102** to recover data present in one or more television channels present in those bands of the signal S. The data processing

'008 Patent, 3:61-64

FIG. 1B

34

The function of the data processing module is to recover data in the TV channels it receives from the channelizer. The customer can then watch those channels on their TV.

'008 AND '826 PATENTS: SPECTRUM MONITORING

Monitoring Module

The monitoring module **154** may be operable to analyze the band C_{J+1} that it receives from the channelizer **102** to measure/determine characteristics such as, for example, signal power level vs. frequency, delay vs. frequency, phase shift vs. frequency, type and/or amount of modulation, code rate, interference levels, signal to noise ratio, a transfer function of the channel of over which the signal was received, an impulse response of the channel over which the signal was received, and/or any other characteristic that may help assess characteristics of the channel over which the signal was received, assess characteristics of the transmitter that sent the signal and/or any otherwise be pertinent to performance of the communication system. The monitoring module may also be

'008 Patent, 3:33-45

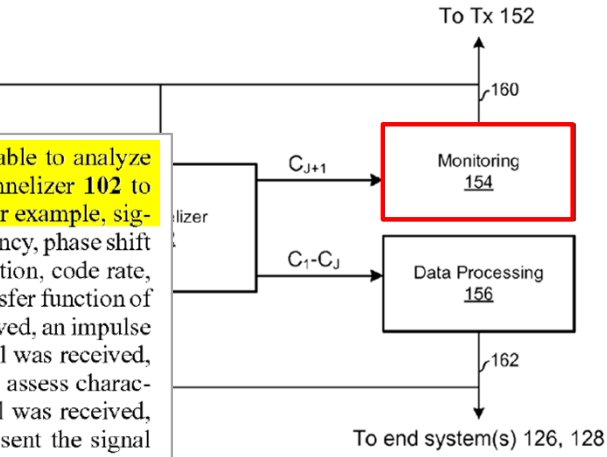


FIG. 1B

35

The job of the monitoring module is to measure or determine characteristics of the frequency band it receives from the channelizer.

'008 AND '826 PATENTS: SPECTRUM MONITORING

Monitoring Module

The monitoring module **154** may be operable to analyze the band C_{J+1} that it receives from the channelizer **102** to measure/determine characteristics such as, for example, signal power level vs. frequency, delay vs. frequency, phase shift vs. frequency, type and/or amount of modulation, code rate, interference levels, signal to noise ratio, a transfer function of the channel of over which the signal was received, an impulse response of the channel over which the signal was received, and/or any other characteristic that may help assess characteristics of the channel over which the signal was received, assess characteristics of the transmitter that sent the signal and/or any otherwise be pertinent to performance of the communication system. The monitoring module may also be

'008 Patent, 3:33-45

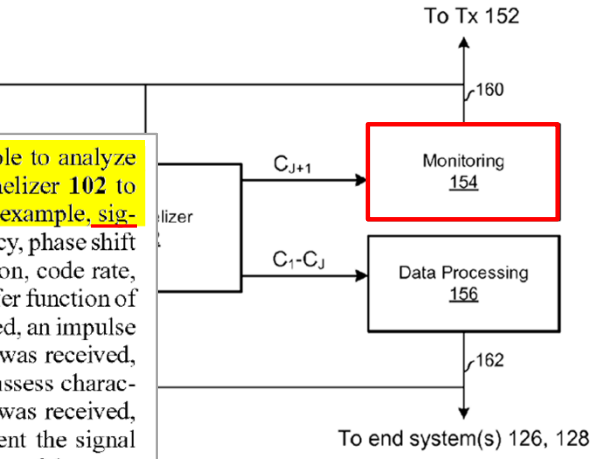


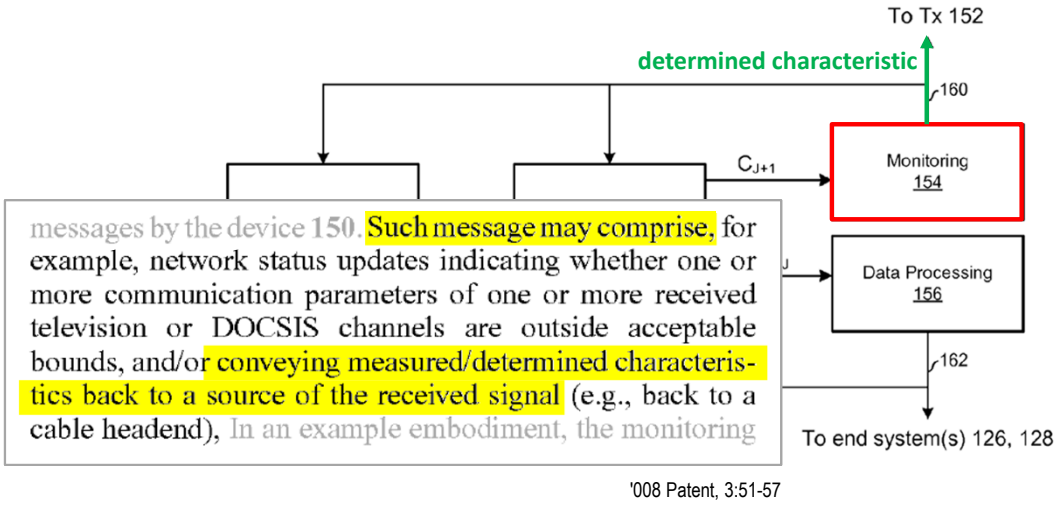
FIG. 1B

36

As the specification explains, one example of a characteristic that the monitoring module can determine is signal power level versus frequency.

'008 AND '826 PATENTS: SPECTRUM MONITORING

Monitoring Module



messages by the device 150. Such message may comprise, for example, network status updates indicating whether one or more communication parameters of one or more received television or DOCSIS channels are outside acceptable bounds, and/or conveying measured/determined characteristics back to a source of the received signal (e.g., back to a cable headend), In an example embodiment, the monitoring

'008 Patent, 3:51-57

FIG. 1B

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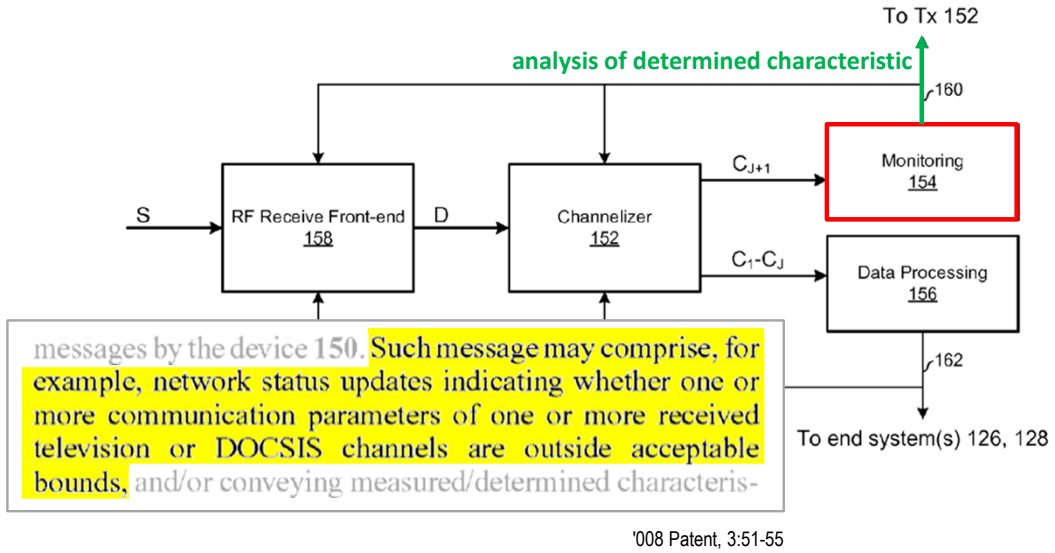
After the monitoring module determines a characteristic of the frequency band, it can send that determined characteristic back to the headend.

'008 AND '826 PATENTS: SPECTRUM MONITORING

Monitoring Module



messages by the device 150. Such message may comprise, for example, network status updates indicating whether one or more communication parameters of one or more received television or DOCSIS channels are outside acceptable bounds, and/or conveying measured/determined characteris-

'008 Patent, 3:51-55

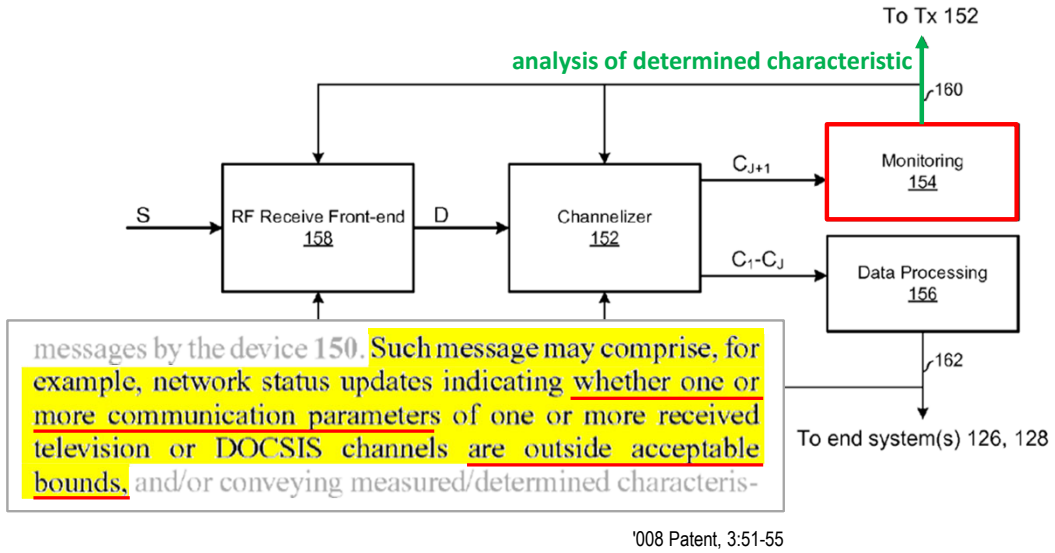
FIG. 1B

38

Alternatively, the monitoring module can analyze the determined characteristic and send that analysis back to the headend.

'008 AND '826 PATENTS: SPECTRUM MONITORING

Monitoring Module



messages by the device 150. Such message may comprise, for example, network status updates indicating whether one or more communication parameters of one or more received television or DOCSIS channels are outside acceptable bounds, and/or conveying measured/determined characteris-

'008 Patent, 3:51-55

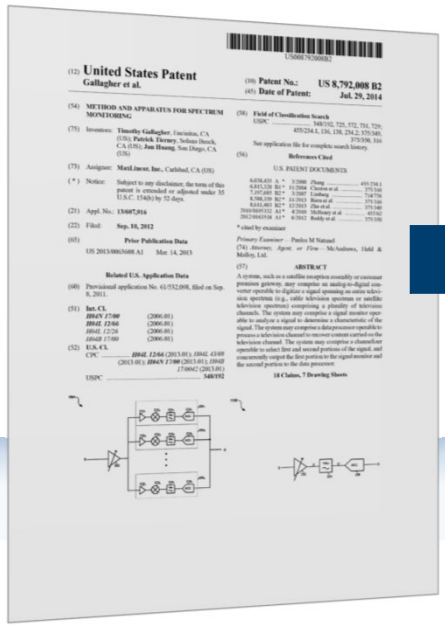
FIG. 1B

39

In the specification, the example given is an analysis of whether communication parameters of the received channels are outside acceptable bounds.

'008 AND '826 PATENTS: SPECTRUM MONITORING

'008 Patent



(12) United States Patent
Gallagher et al.

(10) Patent No.: US 8,792,008 B2
(45) Date of Patent: Jul. 29, 2014

(54) METHOD AND APPARATUS FOR SPECTRUM MONITORING

(75) Inventors: Timothy Gallagher, Encinitas, CA (US); Patrick Tierney, Solana Beach, CA (US); Jun Huang, San Diego, CA (US)

(73) Assignee: MaxLinear, Inc., Carlsbad, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 52 days.

(21) Appl. No.: 13/607,916

(22) Filed: Sep. 10, 2012

(65) Prior Publication Data

US 2013/0063608 A1 Mar. 14, 2013

Related U.S. Application Data

(60) Provisional application No. 61/532,008, filed on Sep. 8, 2011.

(51) Int. Cl.
H04N 17/00 (2006.01)
H04L 12/66 (2006.01)
H04L 12/26 (2006.01)
H04B 17/00 (2006.01)

(52) U.S. Cl.
CPC *H04L 12/66* (2013.01); *H04L 43/08* (2013.01); *H04N 17/00* (2013.01); *H04B 17/0042* (2013.01)
USPC 348/192

(58) Field of Classification Search
USPC 348/192, 725, 572, 731, 729; 455/234.1, 136, 138, 254.2; 375/340, 375/350, 316
See application file for complete search history.

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* cited by examiner

Primary Examiner — Paulos M Natnael
(74) Attorney, Agent, or Firm — McAndrews, Held & Malloy, Ltd.

(57) ABSTRACT

A system, such as a satellite reception assembly or customer premises gateway, may comprise an analog-to-digital converter operable to digitize a signal spanning an entire television spectrum (e.g., cable television spectrum or satellite television spectrum) comprising a plurality of television channels. The system may comprise a signal monitor operable to analyze a signal to determine a characteristic of the signal. The system may comprise a data processor operable to process a television channel to recover content carried on the television channel. The system may comprise a channelizer operable to select first and second portions of the signal, and concurrently output the first portion to the signal monitor and the second portion to the data processor.

18 Claims, 7 Drawing Sheets

Asserted Claim 1

40

Now we'll take a brief look at some select claim limitations. Claim 1 is the only asserted independent claim in the 008 patent, so that's the claim we'll look at.

'008 AND '826 PATENTS: SPECTRUM MONITORING

'008 Patent, Claim 1

1. A system comprising:

an analog-to-digital converter operable to digitize a received signal spanning an entire television spectrum comprising a plurality of television channels, said digitization resulting in a digitized signal;

a signal monitor operable to:

analyze said digitized signal to determine a characteristic of said digitized signal; and

report said determined characteristic to a source of said received signal;

a data processor operable to process a television channel to recover content carried on the television channel; and

a channelizer operable to:

select a first portion of said digitized signal;

select a second portion of said digitized signal; and

concurrently output said first portion of said digitized signal to said signal monitor and said second portion of said digitized signal to said data processor.

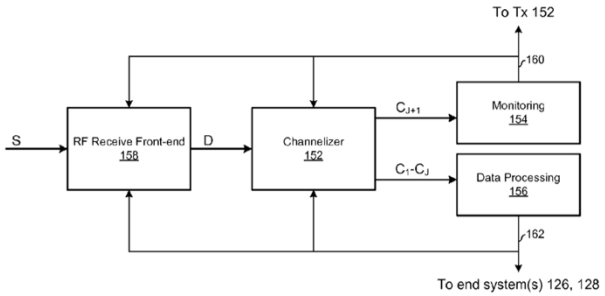


FIG. 1B

41

Claim 1 of the 008 patent is a system claim.

'008 AND '826 PATENTS: SPECTRUM MONITORING

'008 Patent, Claim 1

1. A system comprising:

an analog-to-digital converter operable to digitize a received signal spanning an entire television spectrum comprising a plurality of television channels, said digitization resulting in a digitized signal;

a signal monitor operable to:

analyze said digitized signal to determine a characteristic of said digitized signal; and

report said determined characteristic to a source of said received signal;

a data processor operable to process a television channel to recover content carried on the television channel; and

a channelizer operable to:

select a first portion of said digitized signal;

select a second portion of said digitized signal; and

concurrently output said first portion of said digitized signal to said signal monitor and said second portion of said digitized signal to said data processor.

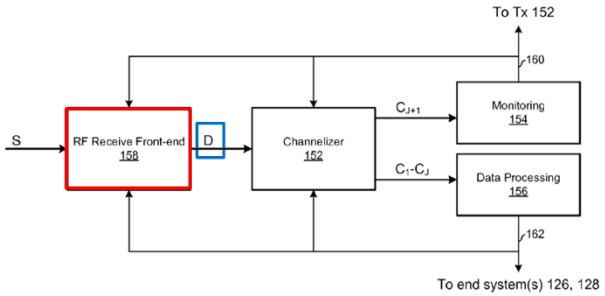


FIG. 1B

42

The first element of claim 1 is directed to an analog to digital converter, which corresponds to the RF Receive Front End 158 in figure 1B.

'008 AND '826 PATENTS: SPECTRUM MONITORING

'008 Patent, Claim 1

1. A system comprising:

an analog-to-digital converter operable to digitize a received signal spanning an entire television spectrum comprising a plurality of television channels, said digitization resulting in a digitized signal;

a signal monitor operable to:

analyze said digitized signal to determine a characteristic of said digitized signal; and

report said determined characteristic to a source of said received signal;

a data processor operable to process a television channel to recover content carried on the television channel; and

a channelizer operable to:

select a first portion of said digitized signal;

select a second portion of said digitized signal; and

concurrently output said first portion of said digitized signal to said signal monitor and said second portion of said digitized signal to said data processor.

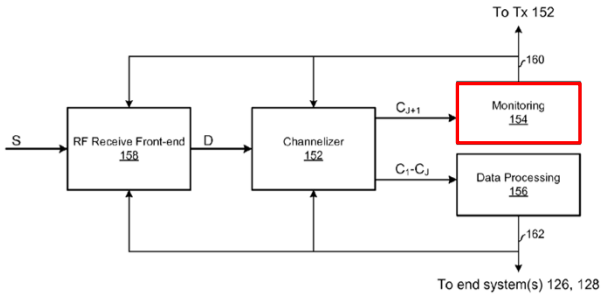


FIG. 1B

43

Next, the claim requires a signal monitor. The claimed signal monitor corresponds to the monitoring module 154 in figure 1B.

The claimed signal monitor is said to be operable to perform 2 functions.

'008 AND '826 PATENTS: SPECTRUM MONITORING

'008 Patent, Claim 1

1. A system comprising:

an analog-to-digital converter operable to digitize a received signal spanning an entire television spectrum comprising a plurality of television channels, said digitization resulting in a digitized signal;

a signal monitor operable to:

analyze said digitized signal to determine a characteristic of said digitized signal; and

report said determined characteristic to a source of said received signal;

a data processor operable to process a television channel to recover content carried on the television channel; and

a channelizer operable to:

select a first portion of said digitized signal;

select a second portion of said digitized signal; and

concurrently output said first portion of said digitized signal to said signal monitor and said second portion of said digitized signal to said data processor.

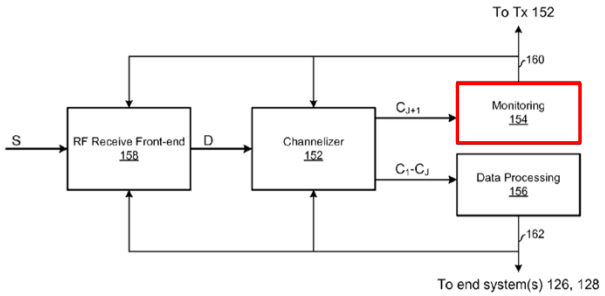


FIG. 1B

44

First, it is operable to determine a characteristic of the digitized signal.

'008 AND '826 PATENTS: SPECTRUM MONITORING

'008 Patent, Claim 1

1. A system comprising:
an analog-to-digital converter operable to digitize a received signal spanning an entire television spectrum comprising a plurality of television channels, said digitization resulting in a digitized signal;
a signal monitor operable to:
analyze said digitized signal to determine a characteristic of said digitized signal; and
report said determined characteristic to a source of said received signal;
a data processor operable to process a television channel to recover content carried on the television channel; and
a channelizer operable to:
select a first portion of said digitized signal;
select a second portion of said digitized signal; and
concurrently output said first portion of said digitized signal to said signal monitor and said second portion of said digitized signal to said data processor.

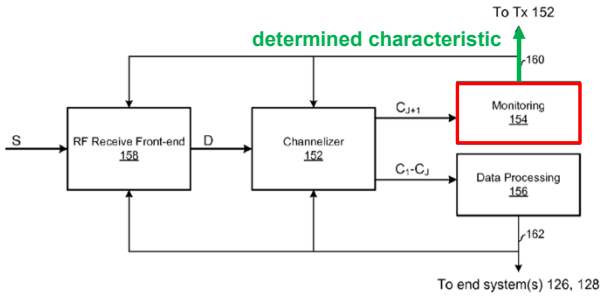


FIG. 1B

45

Second, the signal monitor reports that determined characteristic.

So in this claim, it is the determined characteristic itself that is reported back, not some analysis of the characteristic.

'008 AND '826 PATENTS: SPECTRUM MONITORING

'008 Patent, Claim 1

1. A system comprising:
an analog-to-digital converter operable to digitize a received signal spanning an entire television spectrum comprising a plurality of television channels, said digitization resulting in a digitized signal;
a signal monitor operable to:
analyze said digitized signal to determine a characteristic of said digitized signal; and
report said determined characteristic to a source of said received signal;
a data processor operable to process a television channel to recover content carried on the television channel; and
a channelizer operable to:
select a first portion of said digitized signal;
select a second portion of said digitized signal; and
concurrently output said first portion of said digitized signal to said signal monitor and said second portion of said digitized signal to said data processor.

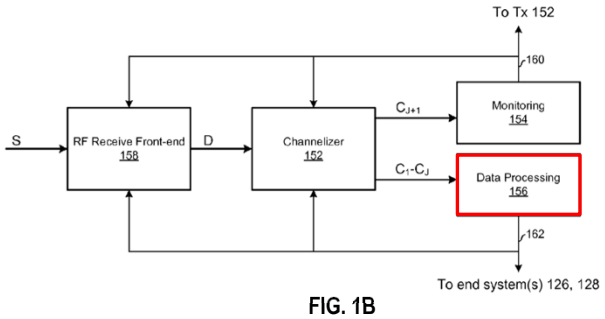


FIG. 1B

46

Next, the claim recites a data processor. This would correspond to the data processing module 156 in FIG. 1B.

'008 AND '826 PATENTS: SPECTRUM MONITORING

'008 Patent, Claim 1

1. A system comprising:
an analog-to-digital converter operable to digitize a received signal spanning an entire television spectrum comprising a plurality of television channels, said digitization resulting in a digitized signal;
a signal monitor operable to:
analyze said digitized signal to determine a characteristic of said digitized signal; and
report said determined characteristic to a source of said received signal;
a data processor operable to process a television channel to recover content carried on the television channel; and
a channelizer operable to:
select a first portion of said digitized signal;
select a second portion of said digitized signal; and
concurrently output said first portion of said digitized signal to said signal monitor and said second portion of said digitized signal to said data processor.

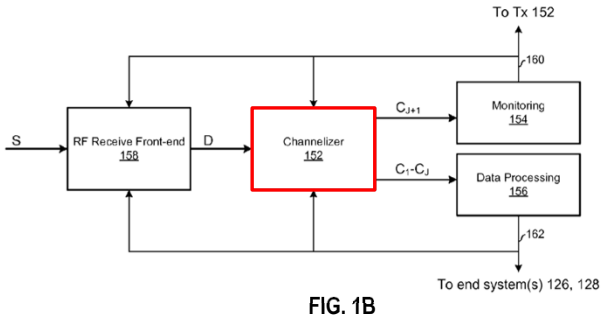


FIG. 1B

47

And finally, the claim requires a channelizer, which corresponds to channelizer 152 in Figure 1B.

The claimed channelizer is said to be operable to perform three tasks.

'008 AND '826 PATENTS: SPECTRUM MONITORING

'008 Patent, Claim 1

1. A system comprising:

an analog-to-digital converter operable to digitize a received signal spanning an entire television spectrum comprising a plurality of television channels, said digitization resulting in a digitized signal;

a signal monitor operable to:

analyze said digitized signal to determine a characteristic of said digitized signal; and

report said determined characteristic to a source of said received signal;

a data processor operable to process a television channel to recover content carried on the television channel; and

a channelizer operable to:

select a first portion of said digitized signal;

select a second portion of said digitized signal; and

concurrently **output said first portion of said digitized signal to said signal monitor** and said second portion of said digitized signal to said data processor.

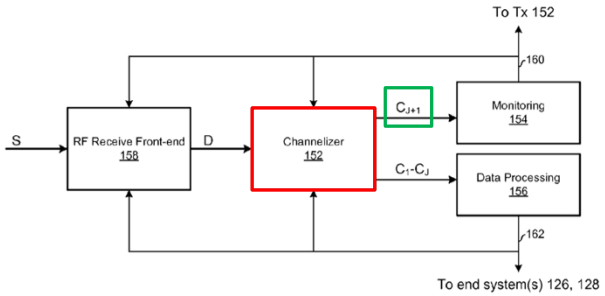


FIG. 1B

48

First, the channelizer selects a first portion of the digitized signal to output to the signal monitor.

'008 AND '826 PATENTS: SPECTRUM MONITORING

'008 Patent, Claim 1

1. A system comprising:
an analog-to-digital converter operable to digitize a received signal spanning an entire television spectrum comprising a plurality of television channels, said digitization resulting in a digitized signal;

a signal monitor operable to:
analyze said digitized signal to determine a characteristic of said digitized signal; and

report said determined characteristic to a source of said received signal;

a data processor operable to process a television channel to recover content carried on the television channel; and

a channelizer operable to:
select a first portion of said digitized signal;
select a second portion of said digitized signal; and
concurrently **output** said first portion of said digitized signal to said signal monitor and **said second portion of said digitized signal to said data processor**.

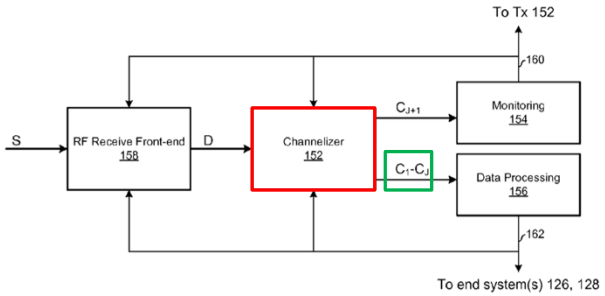


FIG. 1B

49

Second, the channelizer selects a second portion of the digitized signal to output to the data processor.

'008 AND '826 PATENTS: SPECTRUM MONITORING

'008 Patent, Claim 1

1. A system comprising:

an analog-to-digital converter operable to digitize a received signal spanning an entire television spectrum comprising a plurality of television channels, said digitization resulting in a digitized signal;

a signal monitor operable to:

analyze said digitized signal to determine a characteristic of said digitized signal; and

report said determined characteristic to a source of said received signal;

a data processor operable to process a television channel to recover content carried on the television channel; and

a channelizer operable to:

select a first portion of said digitized signal;

select a second portion of said digitized signal; and

concurrently output said first portion of said digitized signal to said signal monitor and said second portion of said digitized signal to said data processor.

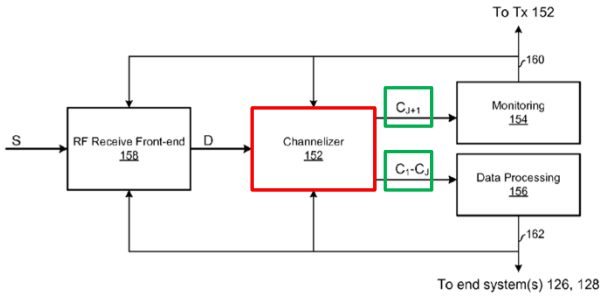


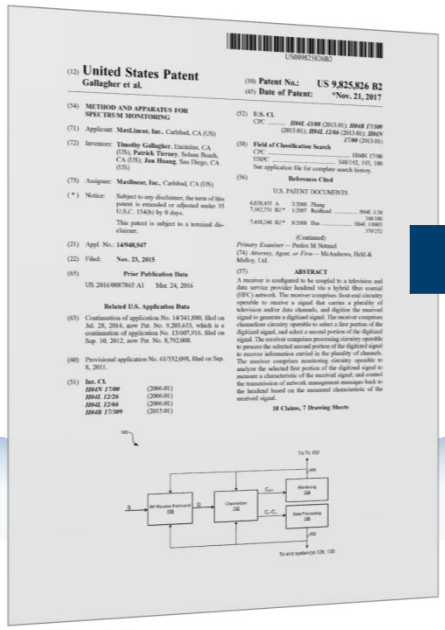
FIG. 1B

50

And third, the channelizer concurrently outputs the selected first portion and second portion to the signal monitor and the data processor, respectively.

'008 AND '826 PATENTS: SPECTRUM MONITORING

'826 Patent



(12) **United States Patent**
Gallagher et al.

(10) **Patent No.: US 9,825,826 B2**
(45) **Date of Patent: *Nov. 21, 2017**

(54) **METHOD AND APPARATUS FOR SPECTRUM MONITORING**

(71) Applicant: **MaxLinear, Inc.**, Carlsbad, CA (US)

(72) Inventors: **Timothy Gallagher**, Encinitas, CA (US); **Patrick Tierney**, Solana Beach, CA (US); **Jun Huang**, San Diego, CA (US)

(73) Assignee: **MaxLinear, Inc.**, Carlsbad, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **14/948,847**

(22) Filed: **Nov. 23, 2015**

(65) **Prior Publication Data**

US 2016/0087865 A1 Mar. 24, 2016

Related U.S. Application Data

(63) Continuation of application No. 14/341,890, filed on Jul. 28, 2014, now Pat. No. 9,203,653, which is a continuation of application No. 13/607,516, filed on Sep. 10, 2012, now Pat. No. 8,792,008.

(60) Provisional application No. 61/532,098, filed on Sep. 8, 2011.

(51) **Int. Cl.**

H04N 17/00	(2006.01)
H04L 12/26	(2006.01)
H04L 12/66	(2006.01)
H04B 17/309	(2015.01)

(52) **U.S. Cl.**
CPC ***H04L 43/08*** (2013.01); ***H04B 17/309*** (2015.01); ***H04L 12/66*** (2013.01); ***H04N 17/00*** (2013.01)

(58) **Field of Classification Search**
CPC .....
USPC .....
See application file for complete search history.

(56) **References Cited**

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(Continued)

Primary Examiner — Pedro M Nimtzel
(74) *Attorney, Agent, or Firm* — McAndrews, Held & Malloy, Ltd.

(57) **ABSTRACT**

A receiver is configured to be coupled to a television and data service provider headend via a hybrid fiber coaxial (HFC) network. The receiver comprises front-end circuitry operable to receive a signal that carries a plurality of television and/or data channels, and digitize the received signal to generate a digitized signal. The receiver comprises channelizer circuitry operable to select a first portion of the digitized signal, and select a second portion of the digitized signal. The receiver comprises processing circuitry operable to process the selected second portion of the digitized signal to recover information carried in the plurality of channels. The receiver comprises monitoring circuitry operable to analyze the selected first portion of the digitized signal to measure a characteristic of the received signal, and control the transmission of network management messages back to the headend based on the measured characteristic of the received signal.

18 Claims, 7 Drawing Sheets

Asserted Claim 1

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Now we'll take a brief look at one specific limitation of claim 1 of the 826 patent.

'008 AND '826 PATENTS: SPECTRUM MONITORING

'826 Patent, Claim 1

1. A method comprising:

performing by one or more circuits of a receiver coupled to a television and data service provider headend via a hybrid fiber coaxial (HFC) network:

receiving, via said HFC network, a signal that carries a plurality of channels, wherein said channels comprise one or both of television channels and data channels;

digitizing said received signal to generate a digitized signal;

selecting a first portion of said digitized signal;

selecting a second portion of said digitized signal;

processing said selected second portion of said digitized signal to recover information carried in said plurality of channels;

analyzing said selected first portion of said digitized signal to measure a characteristic of said received signal; and

controlling the transmission of network management messages back to said headend based on said measured characteristic of said received signal, wherein said measured characteristic is different than said network management messages.

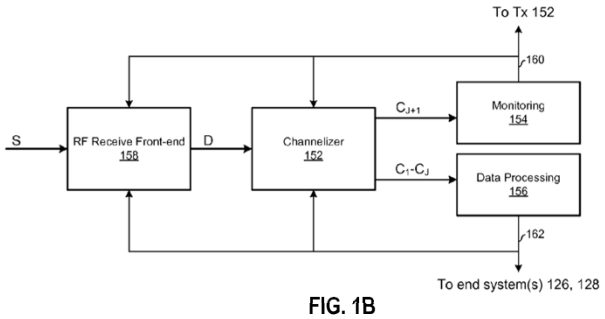


FIG. 1B

52

Claim 1 of the 826 patent is a method claim. In many respects, it simply recites the functions performed by the system claimed in the 008 patent.

'008 AND '826 PATENTS: SPECTRUM MONITORING

'826 Patent, Claim 1

1. A method comprising:

performing by one or more circuits of a receiver coupled to a television and data service provider headend via a hybrid fiber coaxial (HFC) network:

receiving, via said HFC network, a signal that carries a plurality of channels, wherein said channels comprise one or both of television channels and data channels;

digitizing said received signal to generate a digitized signal;

selecting a first portion of said digitized signal;

selecting a second portion of said digitized signal;

processing said selected second portion of said digitized signal to recover information carried in said plurality of channels;

analyzing said selected first portion of said digitized signal to measure a characteristic of said received signal; and

controlling the transmission of network management messages back to said headend based on said measured characteristic of said received signal, wherein said measured characteristic is different than said network management messages.

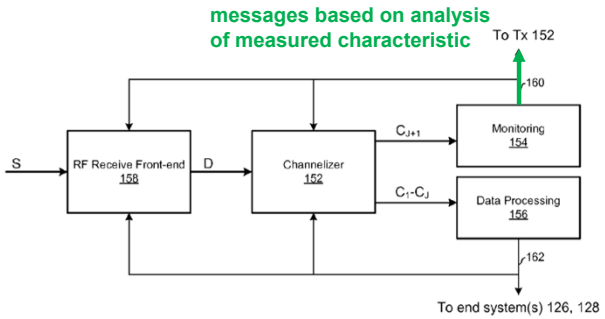


FIG. 1B

53

However, one important difference between this claim and claim 1 of the 008 patent is reflected by the last step of this claim, which we've annotated in green. In this claim, after measuring a characteristic of the signal, what is reported back to the headend is not the measured characteristic itself as in the 008 patent, but instead network management messages that are different than the measured characteristic.

In other words, this claim is directed to the disclosed embodiment where the monitoring module performs an analysis of the measured characteristic and reports the results of that analysis back to the headend.

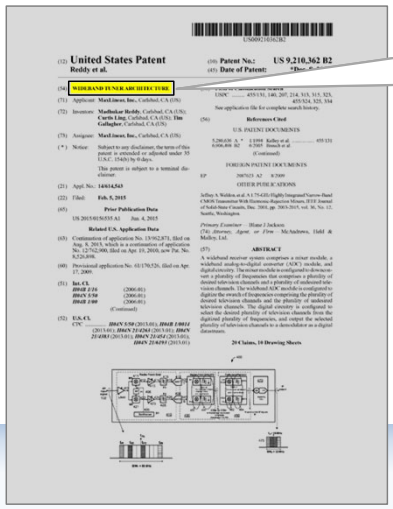
WIDEBAND TUNER ARCHITECTURE

'362 Patent

54

Now we'll turn to the 362 patent.

'362 Patent: Wideband Tuner Architecture



(12) **United States Patent**
Reddy et al.

(10) **Patent No.: US 9,210,362 B2**
(45) **Date of Patent:**

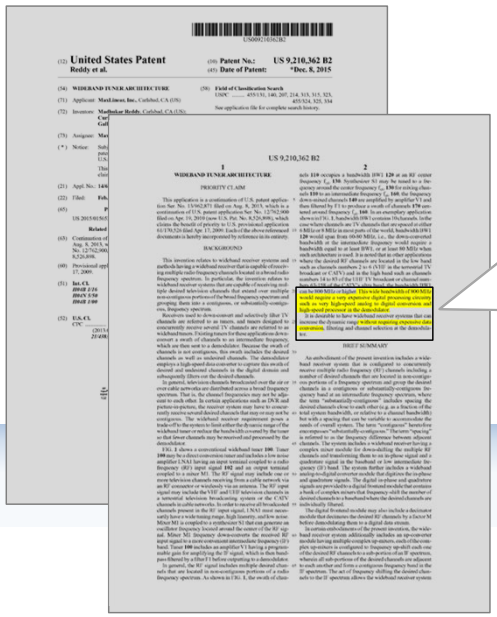
(54) WIDEBAND TUNER ARCHITECTURE

55

As I mentioned earlier, the 362 patent is directed to an allegedly novel architecture for a wideband tuner.

'362 PATENT: WIDEBAND TUNER ARCHITECTURE

Problem To Be Solved



can be 800 MHz or higher. This wide bandwidth of 800 MHz would require a very expensive digital processing circuitry such as very high-speed analog to digital conversion and high-speed processor in the demodulator.

It is desirable to have wideband receiver systems that can increase the dynamic range without requiring expensive data conversion, filtering and channel selection at the demodulator.

'362 Patent, 2:20-27

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According to the patent, existing wideband tuners required expensive analog to digital converters because of the wide bandwidth of the signal that had to be converted.

The objective of the 362 patent is to reduce the bandwidth of the signal to be digitized so that expensive analog to digital converters are not required.

'362 PATENT: WIDEBAND TUNER ARCHITECTURE

Wideband Receiver System

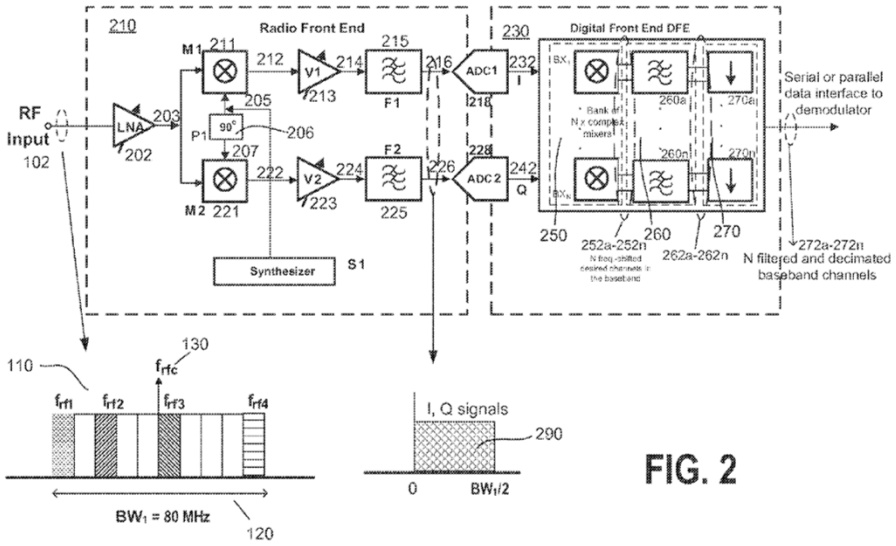


FIG. 2

57

Figure 2 of the 362 patent depicts a wideband receiver system architecture which allegedly solves this problem.

'362 PATENT: WIDEBAND TUNER ARCHITECTURE

Wideband Receiver System

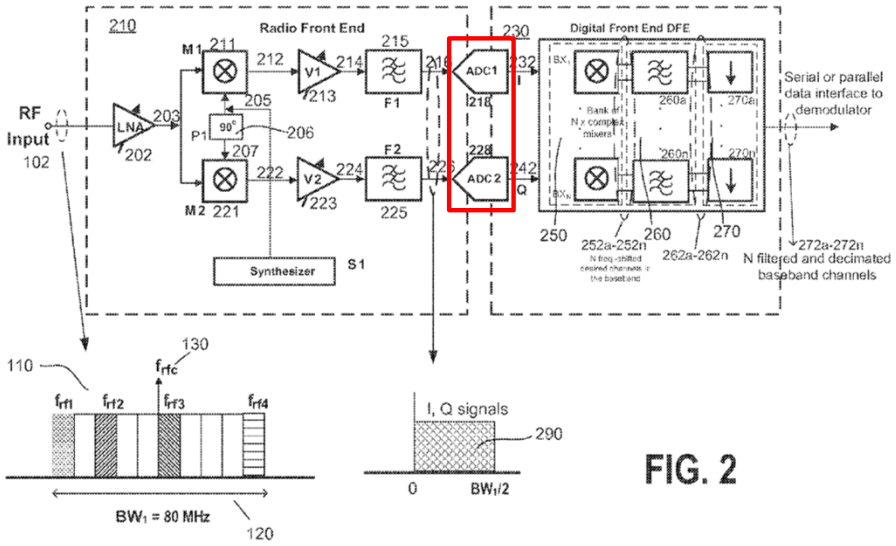


FIG. 2

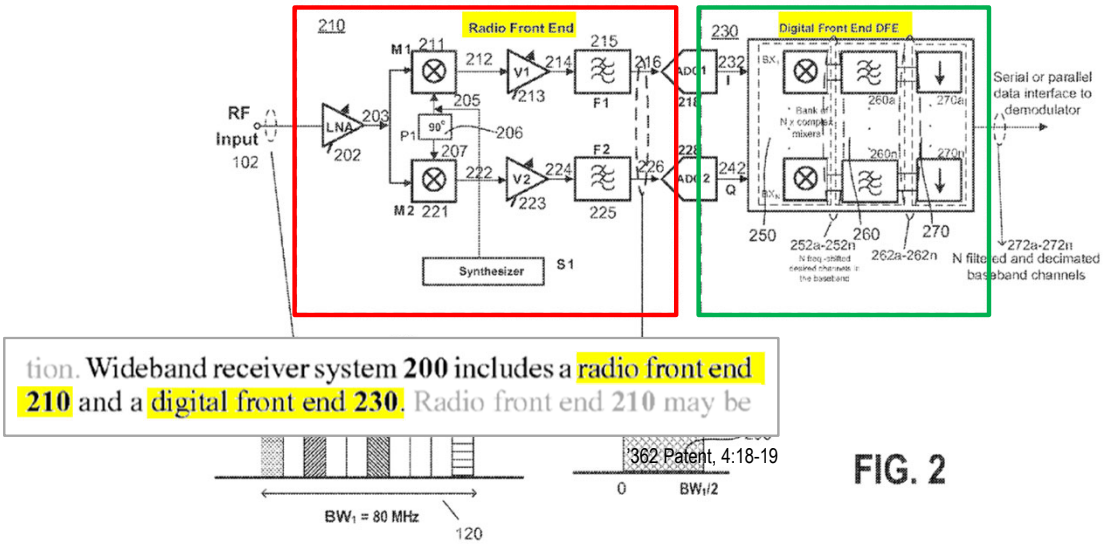
58

We've put a red box around the analog to digital converters in question. The objective of the alleged invention is to reduce the bandwidth of the signal to be supplied to these converters.

We'll now look at how that is done.

'362 PATENT: WIDEBAND TUNER ARCHITECTURE

Radio Front End / Digital Front End



tion. Wideband receiver system **200** includes a radio front end **210** and a digital front end **230**. Radio front end **210** may be

'362 Patent, 4:18-19

FIG. 2

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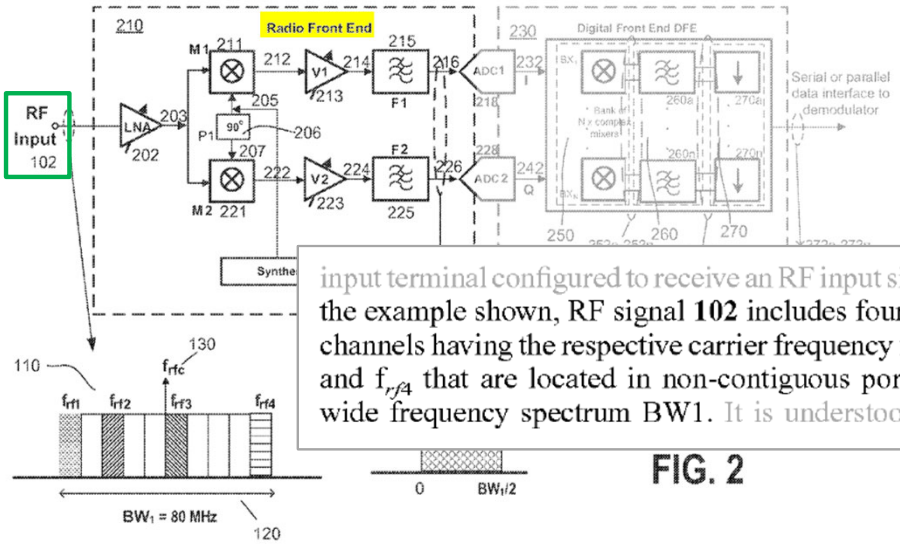
The analog to digital converters sit between two so-called front end components of the wideband receiver -- a radio front end which we've annotated in red, and a digital front end which we've annotated in green.

'362 PATENT: WIDEBAND TUNER ARCHITECTURE

Incoming Signal Contains Non-Contiguous Desired Channels



input terminal configured to receive an RF input signal **102**. In the example shown, RF signal **102** includes four desired RF channels having the respective carrier frequency f_{rf1}, f_{rf2}, f_{rf3}, and f_{rf4} that are located in non-contiguous portions of the wide frequency spectrum BW1. It is understood, however,

FIG. 2

'362 Patent, 4:27-31

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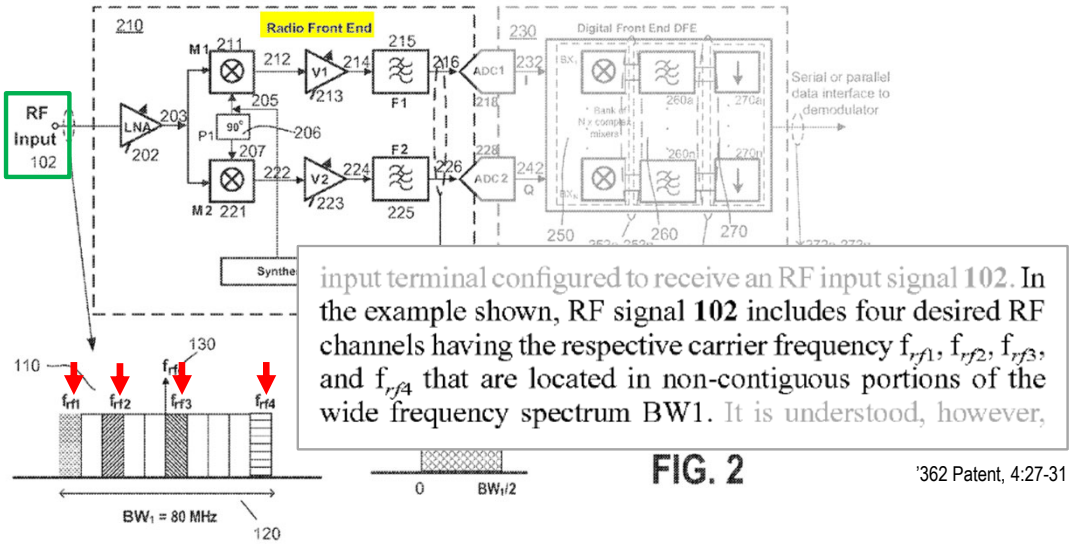
The incoming signal is received into the radio front end at the left of the figure. This signal is referred to as the RF input.

'362 PATENT: WIDEBAND TUNER ARCHITECTURE

Incoming Signal Contains Non-Contiguous Desired Channels



input terminal configured to receive an RF input signal **102**. In the example shown, RF signal **102** includes four desired RF channels having the respective carrier frequency f_{rf1}, f_{rf2}, f_{rf3}, and f_{rf4} that are located in non-contiguous portions of the wide frequency spectrum BW1. It is understood, however,

FIG. 2

'362 Patent, 4:27-31

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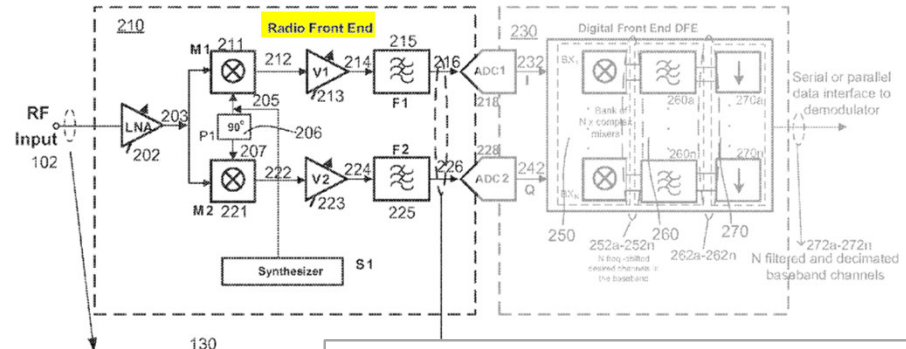
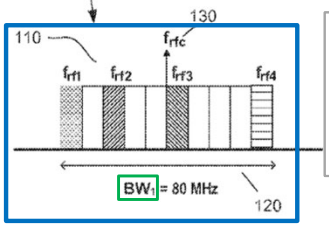
The incoming signal in this example contains 4 desired TV channels. That is, 4 channels the customer might like to view. We have indicated those 4 channels in red. Notice that those 4 channels are not next to each other. They are not contiguous.

'362 PATENT: WIDEBAND TUNER ARCHITECTURE

Initial Bandwidth: BW_1





210 and a digital front end 230. Radio front end 210 may be a single very wide-band tuner receiver that captures the desired swath of channels located in non-contiguous portions of the spectrum having a frequency bandwidth BW1 120. In

'362 Patent, 4:19-22

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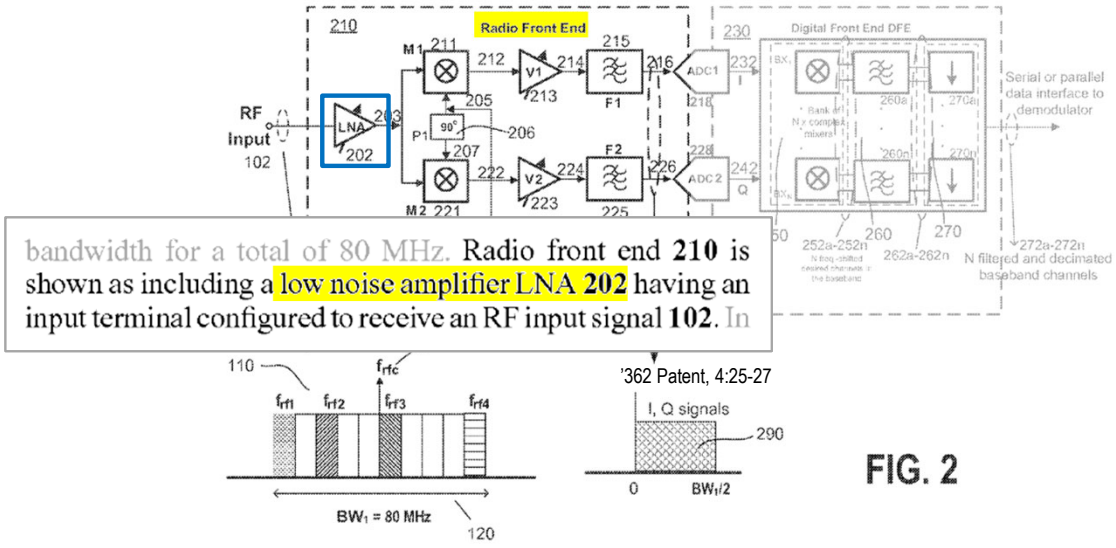
According to the specification, the radio front end somehow captures a swath of channels that includes the desired channels. We've annotated that swath in blue. This desired swath of channels has a bandwidth B W 1, which we've annotated in green.

'362 PATENT: WIDEBAND TUNER ARCHITECTURE

Low Noise Amplifier



bandwidth for a total of 80 MHz. Radio front end **210** is shown as including a low noise amplifier LNA **202** having an input terminal configured to receive an RF input signal **102**. In

'362 Patent, 4:25-27

FIG. 2

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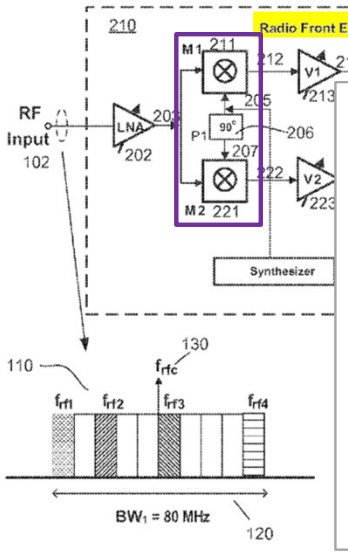
This desired swath of channels is first sent to a low noise amplifier annotated in blue.

'362 PATENT: WIDEBAND TUNER ARCHITECTURE

Mixer Module



Mixers M1 **211** and M2 **221** may be conventional mixers formed using, for example, differential Gilbert cells. Each of the mixers **211** and **221** multiplies (mixes) an amplified RF signal **203** with a respective first oscillator frequency signal **205** and a second oscillator frequency signal **207** to generate an in-phase signal **212** and a quadrature signal **222** that have a phase shift of 90° degree between them. Mixers **211** and **221** are identical so that the amplitude of the in-phase signal **212** and quadrature signal **222** are the same. The first and second oscillator frequencies **205** and **207** are identical and have a 90° degree phase shift generated through a 90° degree phase shifter P1 **206**. Synthesizer S1 may be a single local oscillator operable to generate the oscillator frequency **205** for converting the receive RF signal **102** to a zero-IF or low-IF band.

'362 Patent, 4:40-53

64

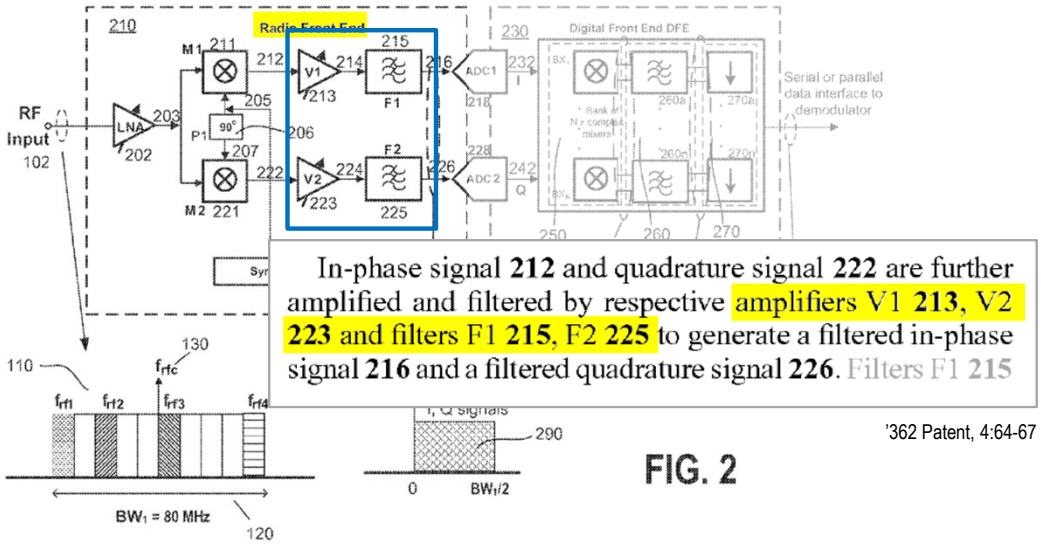
Next, the amplified signal is provided as input to a mixer module, annotated in purple. The mixer module performs two functions:

First, the signal is "down-converted," meaning the received signal is shifted to a lower range of frequencies. This is described in the language from the specification we've highlighted in green.

Second, the mixer module generates I and Q signals. The details of I and Q signals are beyond the scope of this technology tutorial, but they refer to in-phase and quadrature components of the signal.

'362 PATENT: WIDEBAND TUNER ARCHITECTURE

Amplifiers/Filters



In-phase signal **212** and quadrature signal **222** are further amplified and filtered by respective amplifiers V1 **213**, V2 **223** and filters F1 **215**, F2 **225** to generate a filtered in-phase signal **216** and a filtered quadrature signal **226**. Filters F1 **215**

'362 Patent, 4:64-67

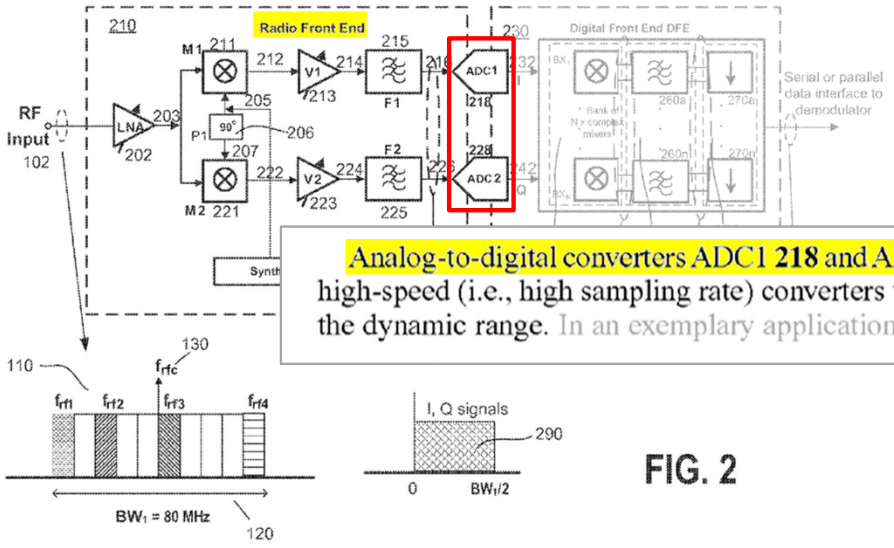
FIG. 2

65

Next, the signals are sent to amplifiers and filters.

'362 PATENT: WIDEBAND TUNER ARCHITECTURE

A-D Converters



Analog-to-digital converters ADC1 **218** and ADC2 **228** are high-speed (i.e., high sampling rate) converters to maximize the dynamic range. In an exemplary application, radio front

'362 Patent, 5:13-15

FIG. 2

66

And after this, the signals are provided as input to the analog to digital converters we discussed earlier.

'362 PATENT: WIDEBAND TUNER ARCHITECTURE

Bandwidth Reduced by Half

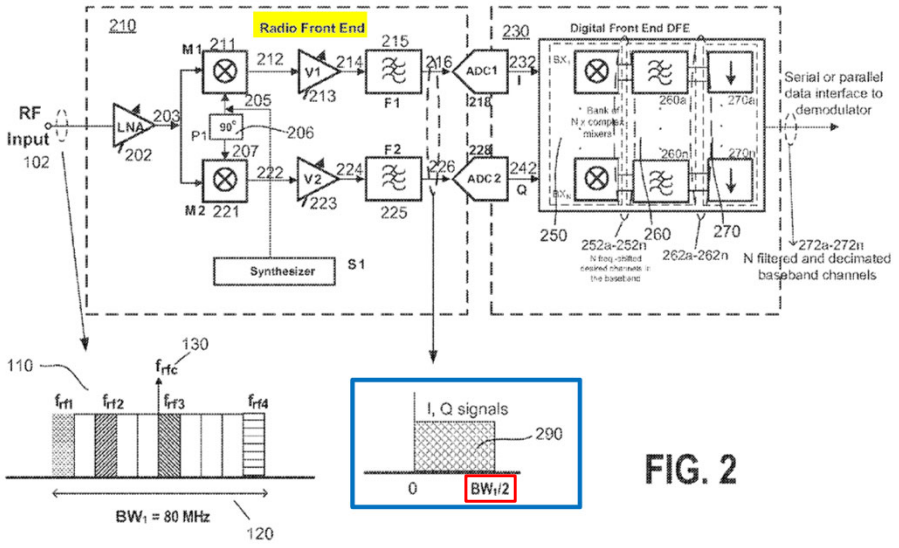


FIG. 2

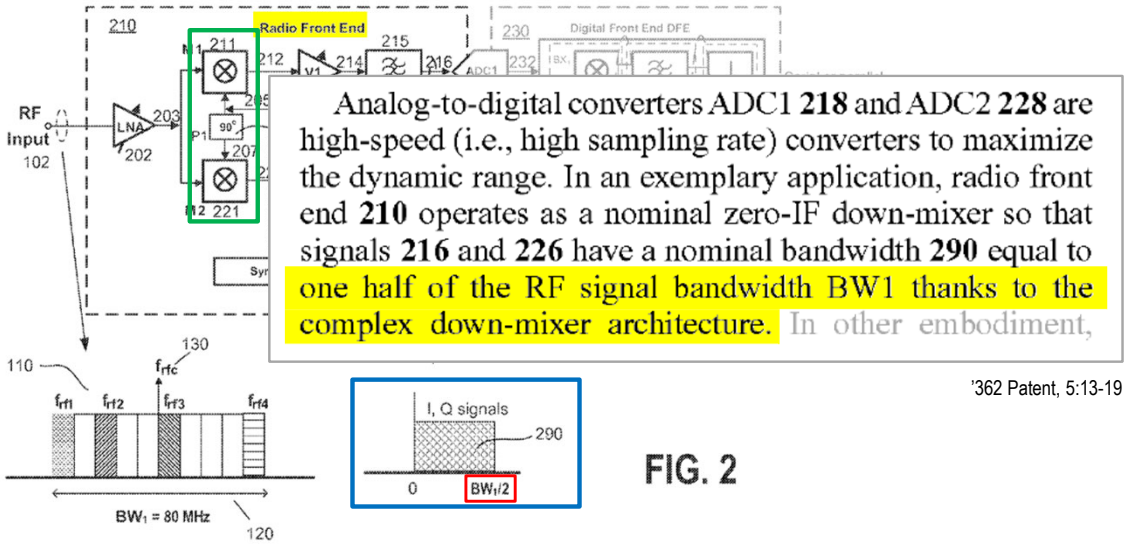
67

Notice, as we have annotated in red in figure 2, that that bandwidth of the signal supplied to the analog to digital converters is one half of the initial bandwidth BW 1.

That is the reduction in bandwidth which allows less expensive analog to digital converters to be used.

'362 PATENT: WIDEBAND TUNER ARCHITECTURE

Mixer Module 211 Achieves the Bandwidth Reduction



Analog-to-digital converters ADC1 **218** and ADC2 **228** are high-speed (i.e., high sampling rate) converters to maximize the dynamic range. In an exemplary application, radio front end **210** operates as a nominal zero-IF down-mixer so that signals **216** and **226** have a nominal bandwidth **290** equal to one half of the RF signal bandwidth BW1 thanks to the complex down-mixer architecture. In other embodiment,

'362 Patent, 5:13-19

FIG. 2

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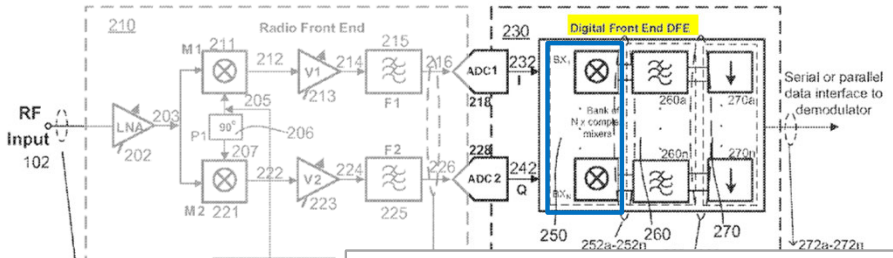
And as the specification explains, it is the mixer module 211 annotated in green, that achieves this reduction in bandwidth.

'362 PATENT: WIDEBAND TUNER ARCHITECTURE

Mixers to Extract Desired Channels



Each of the N complex mixers **250** receives the digital signals I **232** and Q **242** from ADCs **218** and **228** to extract a different one of the desired channels and frequency-shifts the extracted signals to the baseband frequency. Each of the fre-

'362 Patent, 5:49-52

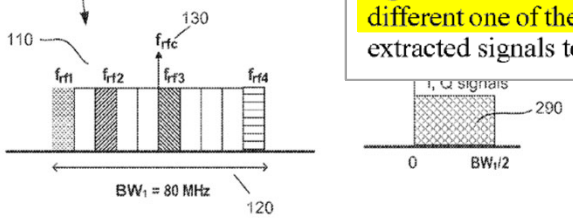


FIG. 2

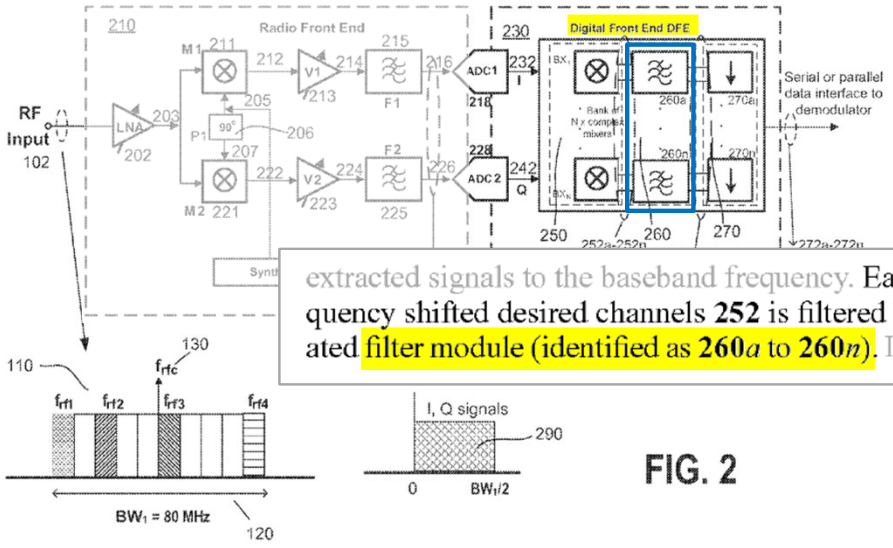
69

After analog to digital conversion, the digitized signals are sent to mixers which extract the desired channels.

'362 PATENT: WIDEBAND TUNER ARCHITECTURE

Filter Module

Filter Module



extracted signals to the baseband frequency. Each of the frequency shifted desired channels **252** is filtered by an associated filter module (identified as **260***a* to **260***n*). In an embodi-

'362 Patent, 5:52-54

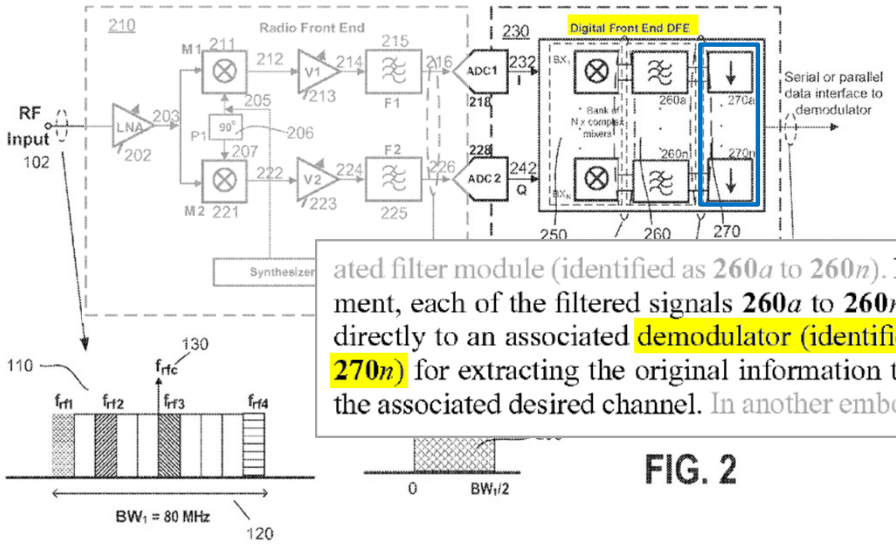
FIG. 2

70

Once extracted, each of the desired channels is provided to a filter module.

'362 PATENT: WIDEBAND TUNER ARCHITECTURE

Demodulators



ated filter module (identified as **260***a* to **260***n*). In an embodiment, each of the filtered signals **260***a* to **260***n* may be sent directly to an associated demodulator (identified as **270***a* to **270***n*) for extracting the original information transmitted in the associated desired channel. In another embodiment, each

FIG. 2

'362 Patent, 5:54-58

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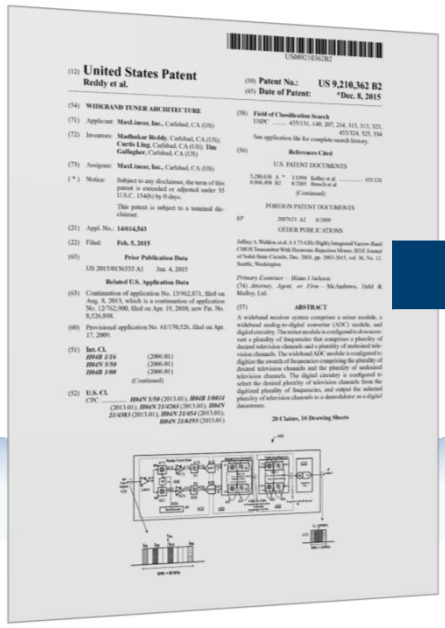
Each of the filtered signals is then provided to an associated demodulator, which extracts the information in the desired channels.

'362 PATENT: WIDEBAND TUNER ARCHITECTURE

'362 Patent



(12) **United States Patent**
Reddy et al.

(10) **Patent No.: US 9,210,362 B2**
(45) **Date of Patent: *Dec. 8, 2015**

(54) **WIDEBAND TUNER ARCHITECTURE**

(71) Applicant: **MaxLinear, Inc.**, Carlsbad, CA (US)

(72) Inventors: **Madhukar Reddy**, Carlsbad, CA (US); **Curtis Ling**, Carlsbad, CA (US); **Tim Gallagher**, Carlsbad, CA (US)

(73) Assignee: **MaxLinear, Inc.**, Carlsbad, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **14/614,543**

(22) Filed: **Feb. 5, 2015**

(65) **Prior Publication Data**

US 2015/0156535 A1 Jun. 4, 2015

Related U.S. Application Data

(63) Continuation of application No. 13/962,871, filed on Aug. 8, 2013, which is a continuation of application No. 12/762,000, filed on Apr. 19, 2010, now Pat. No. 8,526,898.

(60) Provisional application No. 61/170,526, filed on Apr. 17, 2009.

(51) **Int. Cl.**
H04B 1/16 (2006.01)
H04N 5/50 (2006.01)
H04B 1/00 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H04N 5/50*** (2013.01); ***H04B 1/0014*** (2013.01); ***H04N 21/4263*** (2013.01); ***H04N 21/4383*** (2013.01); ***H04N 21/4391*** (2013.01)

(58) **Field of Classification Search**
USPC 455/131, 140, 207, 214, 313, 323, 455/324, 325, 334
See application file for complete search history.

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Primary Examiner — Blane J Jackson
(74) *Attorney, Agent, or Firm* — McAndrews, Held & Malloy, Ltd.

(57) **ABSTRACT**

A wideband receiver system comprises a mixer module, a wideband analog-to-digital converter (ADC) module, and digital circuitry. The mixer module is configured to down-convert a plurality of frequencies that comprises a plurality of desired television channels and a plurality of undesired television channels. The wideband ADC module is configured to digitize the swath of frequencies comprising the plurality of desired television channels and the plurality of undesired television channels. The digital circuitry is configured to select the desired plurality of television channels from the digitized plurality of frequencies, and output the selected plurality of television channels to a demodulator as a digital datastream.

20 Claims, 10 Drawing Sheets

Asserted Claim 11

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Now we will briefly look at some select limitations of claim 11 of the 362 patent, which is the only asserted independent claim.

'362 PATENT: WIDEBAND TUNER ARCHITECTURE

'362 Patent, Claim 11

11. A method comprising:
in a wideband receiver system:

downconverting, by a mixer module of said wideband receiver system, a plurality of frequencies that comprises a plurality of desired television channels and a plurality of undesired television channels;

digitizing, by a wideband analog-to-digital converter (ADC) module of said wideband receiver system, said plurality of frequencies comprising said plurality of desired television channels and said plurality of undesired television channels;

selecting, by digital circuitry of said wideband receiver system, said plurality of desired television channels from said digitized plurality of frequencies; and

outputting, by said digital circuitry of said wideband receiver system, said selected plurality of television channels to a demodulator as a digital datastream.

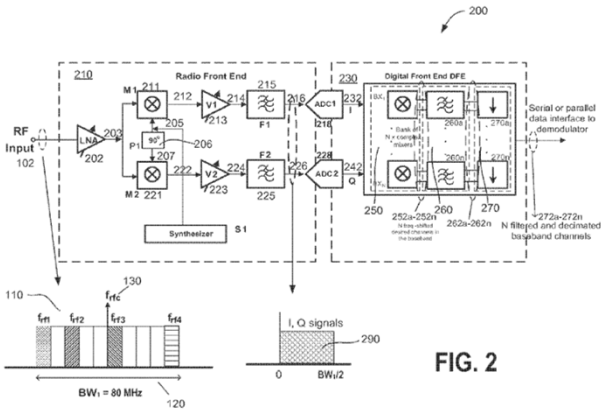

FIG. 2

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Claim 11 is a method claim, whereby the steps are carried out in in a wideband receiver system.

'362 PATENT: WIDEBAND TUNER ARCHITECTURE

'362 Patent, Claim 11

11. A method comprising:

in a wideband receiver system:

downconverting, by a mixer module of said wideband receiver system, a plurality of frequencies that comprises a plurality of desired television channels and a plurality of undesired television channels;

digitizing, by a wideband analog-to-digital converter (ADC) module of said wideband receiver system, said plurality of frequencies comprising said plurality of desired television channels and said plurality of undesired television channels;

selecting, by digital circuitry of said wideband receiver system, said plurality of desired television channels from said digitized plurality of frequencies; and

outputting, by said digital circuitry of said wideband receiver system, said selected plurality of television channels to a demodulator as a digital datastream.

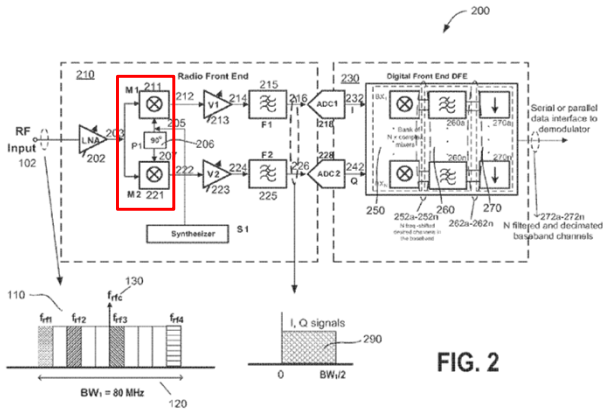

FIG. 2

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The claim begins with the step of down converting by a mixer module This corresponds to the functions of mixer module 211.

'362 PATENT: WIDEBAND TUNER ARCHITECTURE

'362 Patent, Claim 11

11. A method comprising:

in a wideband receiver system:

downconverting, by a mixer module of said wideband receiver system, a plurality of frequencies that comprises a plurality of desired television channels and a plurality of undesired television channels;

digitizing, by a wideband analog-to-digital converter (ADC) module of said wideband receiver system, said plurality of frequencies comprising said plurality of desired television channels and said plurality of undesired television channels;

selecting, by digital circuitry of said wideband receiver system, said plurality of desired television channels from said digitized plurality of frequencies; and

outputting, by said digital circuitry of said wideband receiver system, said selected plurality of television channels to a demodulator as a digital datastream.

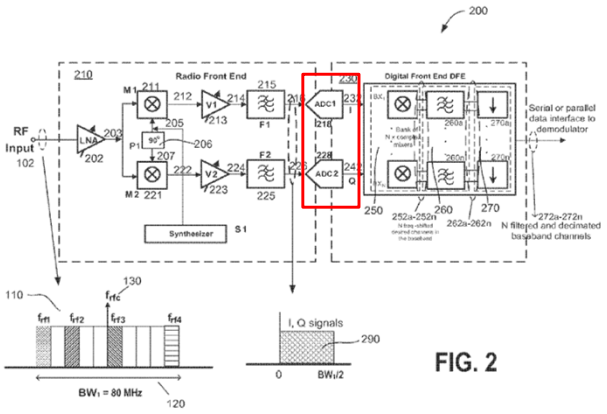

FIG. 2

75

Next, the claim requires digitizing by an analog-to-digital converter module.

We've annotated figure 2 to indicate the analog to digital converters in red.

'362 PATENT: WIDEBAND TUNER ARCHITECTURE

'362 Patent, Claim 11

11. A method comprising:

in a wideband receiver system:

downconverting, by a mixer module of said wideband receiver system, a plurality of frequencies that comprises a plurality of desired television channels and a plurality of undesired television channels;

digitizing, by a wideband analog-to-digital converter (ADC) module of said wideband receiver system, said plurality of frequencies comprising said plurality of desired television channels and said plurality of undesired television channels;

selecting, by digital circuitry of said wideband receiver system, said plurality of desired television channels from said digitized plurality of frequencies; and

outputting, by said digital circuitry of said wideband receiver system, said selected plurality of television channels to a demodulator as a digital datastream.

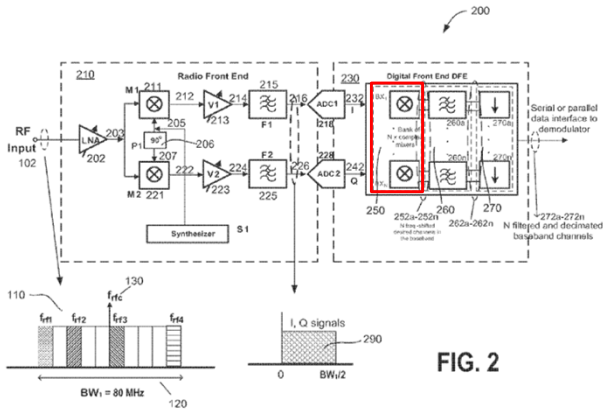

FIG. 2

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After the digitization, the claim requires that digital circuitry select the desired television channels

'362 PATENT: WIDEBAND TUNER ARCHITECTURE

'362 Patent, Claim 11

11. A method comprising:

in a wideband receiver system:

downconverting, by a mixer module of said wideband receiver system, a plurality of frequencies that comprises a plurality of desired television channels and a plurality of undesired television channels;

digitizing, by a wideband analog-to-digital converter (ADC) module of said wideband receiver system, said plurality of frequencies comprising said plurality of desired television channels and said plurality of undesired television channels;

selecting, by digital circuitry of said wideband receiver system, said plurality of desired television channels from said digitized plurality of frequencies; and

outputting, by said digital circuitry of said wideband receiver system, said selected plurality of television channels to a demodulator as a digital datastream.

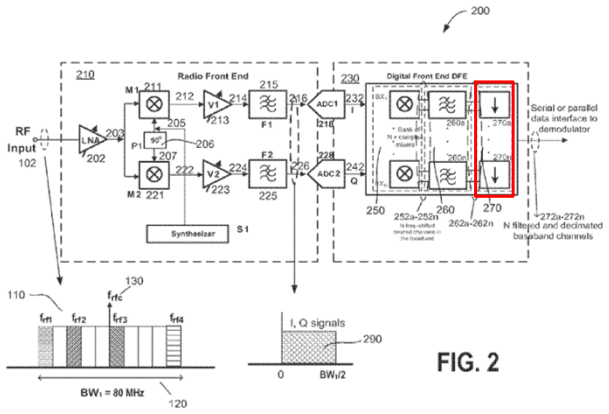

FIG. 2

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And output the selected channels to a demodulator.

CABLE MODEM ARCHITECTURE

'775 Patent

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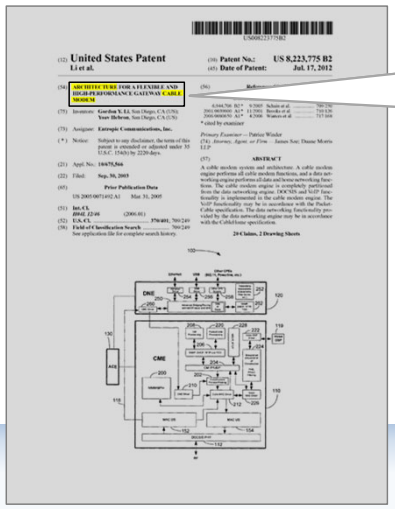
Now we will discuss the 775 patent.

'775 PATENT: CABLE MODEM ARCHITECTURE

'775 Patent: Cable Modem Architecture



(12) United States Patent
Li et al.

(10) Patent No.: US 8,223,775 B2
(45) Date of Patent: Jul. 17, 2012

(54) ARCHITECTURE FOR A FLEXIBLE AND HIGH-PERFORMANCE GATEWAY CABLE MODEM

ABSTRACT

ARCHITECTURE FOR A FLEXIBLE AND HIGH-PERFORMANCE GATEWAY CABLE MODEM

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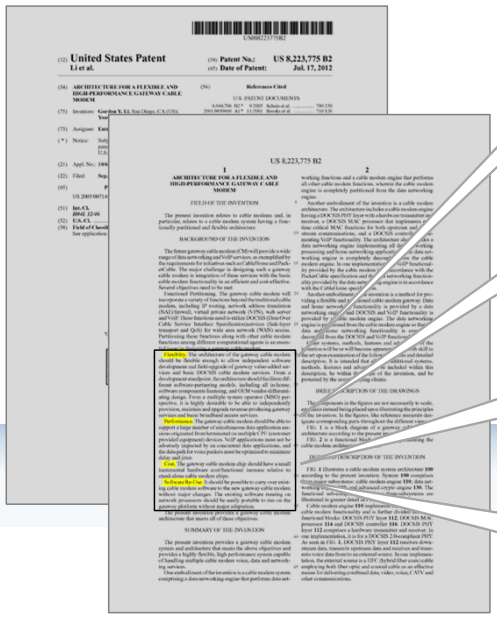
As I mentioned earlier, the 775 patent is directed to an allegedly new architecture for a cable modem.

'775 PATENT: CABLE MODEM ARCHITECTURE

Objectives



Flexiblity. The architecture of the gateway cable modem should be flexible enough to allow independent software development and field-upgrade of gateway value-added ser-

'775 Patent, 1:30-32

Performance. The gateway cable modem should be able to support a large number of simultaneous data application sessions originated from/terminated on multiple CPE (customer

'775 Patent, 1:41-43

Cost. The gateway cable modem chip should have a small incremental hardware cost/functional increase relative to stand-alone cable modem chips.

'775 Patent, 1:48-50

Software Re-Use. It should be possible to carry over existing cable modem software to the new gateway cable modem without major changes. The existing software running on

'775 Patent, 1:51-53

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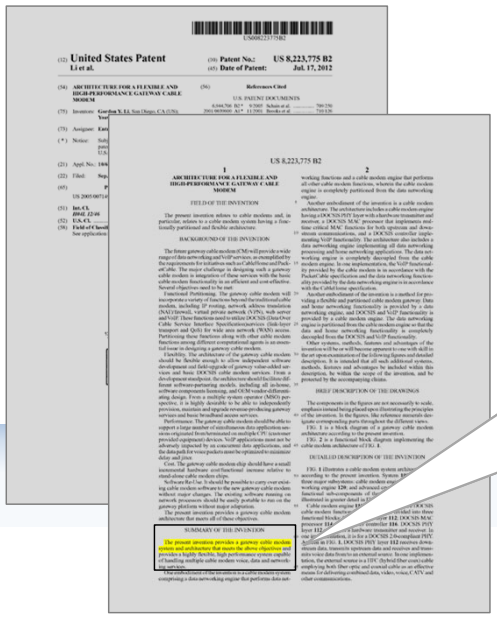
The specification identifies a number of objectives for a new cable modem, such as flexibility, performance, cost and software re-use.

'775 PATENT: CABLE MODEM ARCHITECTURE

Alleged Invention



SUMMARY OF THE INVENTION

The present invention provides a gateway cable modem system and architecture that meets the above objectives and provides a highly flexible, high performance system capable of handling multiple cable modem voice, data and networking services.

'775 Patent, 1:59-65

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The alleged invention is a cable modem architecture which meets all of these objectives

'775 PATENT: CABLE MODEM ARCHITECTURE

Cable Modem Architecture

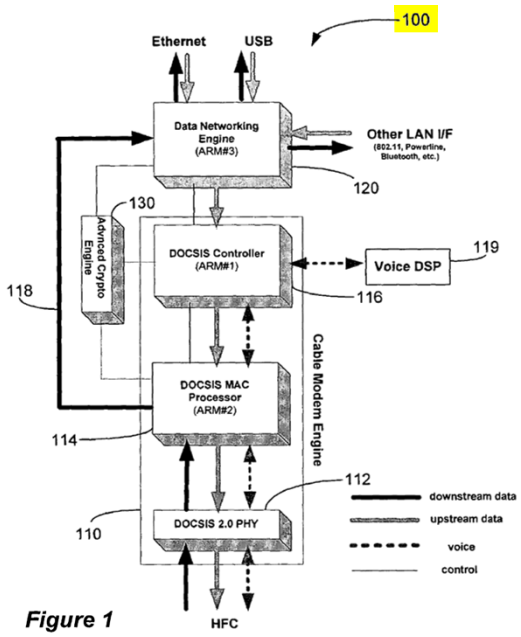

Figure 1

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Figure 1 of the patent depicts the disclosed cable modem architecture. It is described as being the architecture of cable modem 100.

'775 PATENT: CABLE MODEM ARCHITECTURE

Cable Modem Architecture

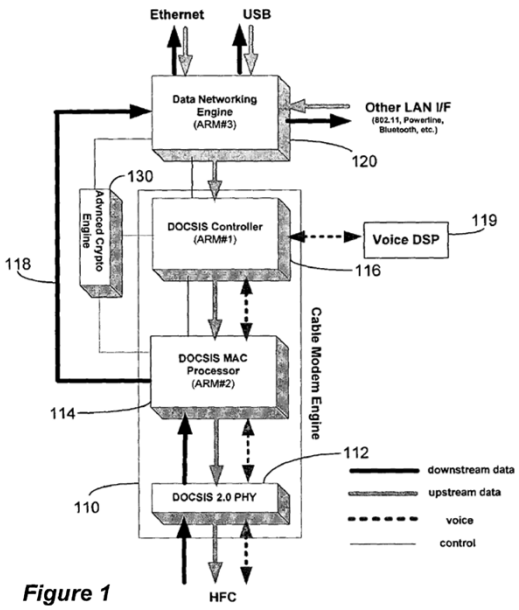

Figure 1

architecture. The architecture includes a cable modem engine having a DOCSIS PHY layer with a hardware transmitter and receiver, a DOCSIS MAC processor that implements real-time critical MAC functions for both upstream and downstream communications, and a DOCSIS controller implementing VoIP functionality. The architecture also includes a data networking engine implementing all data networking processing and home networking applications. The data networking engine is completely decoupled from the cable modem engine. In one implementation, the VoIP functional-

'775 Patent, 2:6-15

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According to the specification, there are several distinct aspects to this cable modem architecture

'775 PATENT: CABLE MODEM ARCHITECTURE

Cable Modem Engine

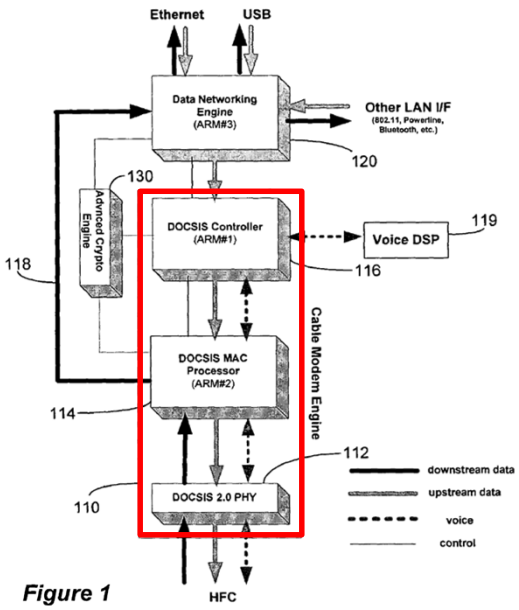

Figure 1

architecture. The architecture includes a cable modem engine having a DOCSIS PHY layer with a hardware transmitter and receiver, a DOCSIS MAC processor that implements real-time critical MAC functions for both upstream and downstream communications, and a DOCSIS controller implementing VoIP functionality. The architecture also includes a data networking engine implementing all data networking processing and home networking applications. The data networking engine is completely decoupled from the cable modem engine. In one implementation, the VoIP functional-

'775 Patent, 2:6-15

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The first is the inclusion of a so-called cable modem engine.

And that cable modem engine is in turn made up of three discrete physical components.

'775 PATENT: CABLE MODEM ARCHITECTURE

Cable Modem Engine Architecture

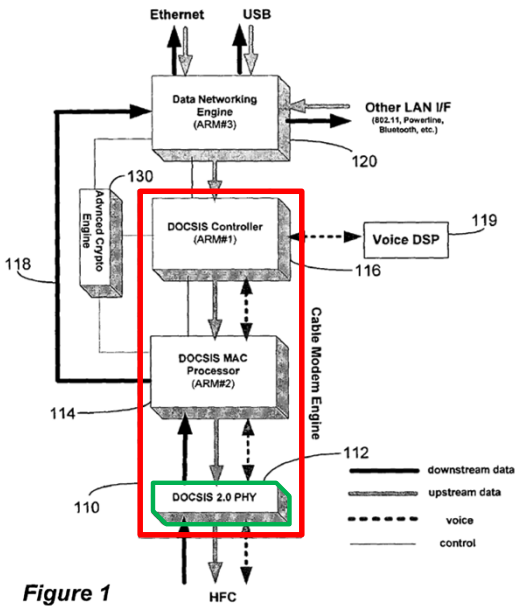

Figure 1

architecture. The architecture includes a cable modem engine having a DOCSIS PHY layer with a hardware transmitter and receiver, a DOCSIS MAC processor that implements real-time critical MAC functions for both upstream and downstream communications, and a DOCSIS controller implementing VoIP functionality. The architecture also includes a

'775 Patent, 2:6-11

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The first is a so-called DOCSIS 2.0 P H Y labeled 112 in the figure.

'775 PATENT: CABLE MODEM ARCHITECTURE

Cable Modem Engine Architecture

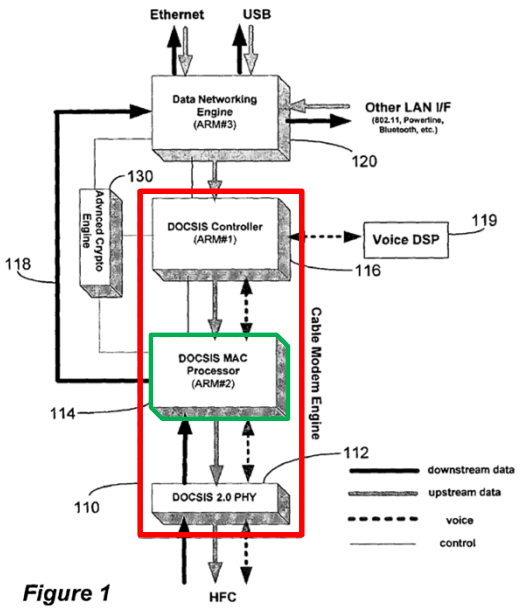

Figure 1

architecture. The architecture includes a cable modem engine having a DOCSIS PHY layer with a hardware transmitter and receiver, a DOCSIS MAC processor that implements real-time critical MAC functions for both upstream and downstream communications, and a DOCSIS controller implementing VoIP functionality. The architecture also includes a

'775 Patent, 2:6-11

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The second is a so-called DOCSIS MAC processor labeled 114 in the figure.

'775 PATENT: CABLE MODEM ARCHITECTURE

Cable Modem Engine Architecture

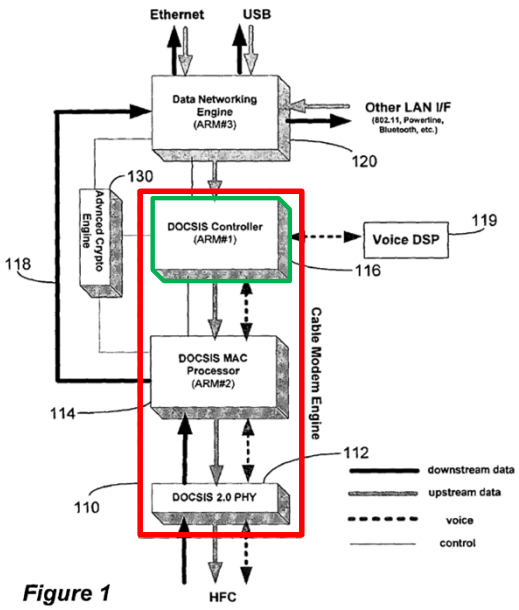

Figure 1

architecture. The architecture includes a cable modem engine having a DOCSIS PHY layer with a hardware transmitter and receiver, a DOCSIS MAC processor that implements real-time critical MAC functions for both upstream and downstream communications, and a DOCSIS controller implementing VoIP functionality. The architecture also includes a

'775 Patent, 2:6-11

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And the third is a so-called DOCSIS Controller labeled 116 in the figure.

Now I'll discuss the disclosed functions of each of those three discrete physical components.

'775 PATENT: CABLE MODEM ARCHITECTURE

DOCSIS 2.0 PHY

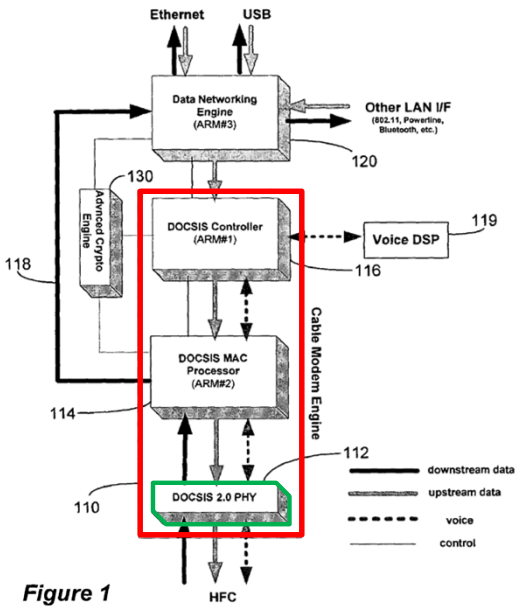

Figure 1

As seen in FIG. 1, DOCSIS PHY layer **112** receives downstream data, transmits upstream data and receives and transmits voice data from/to an external source. In one implementation, the external source is a HFC (hybrid fiber coax) cable employing both fiber optic and coaxial cable as an effective means for delivering combined data, video, voice, CATV and other communications.

'775 Patent, 2:61-67

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The DOCSIS 2.0 P H Y receives downstream voice and other data from the cable network and transmits voice and other data upstream to the cable network.

'775 PATENT: CABLE MODEM ARCHITECTURE

DOCSIS MAC Processor

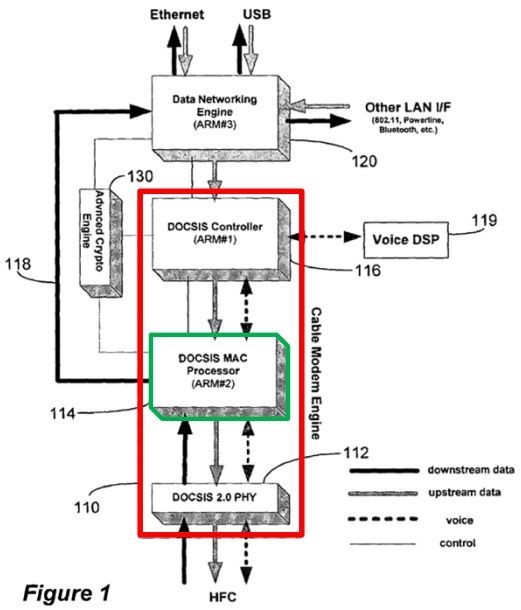


Figure 1

Processor **114** implements real-time critical MAC functions for both upstream (US) and downstream (DS) communications. These functions include US and DS synchronization, DS MAC address filtering, DS protocol filtering, US and DS PHS, concatenation, fragmentation, MAP processing, US transmission scheduling, as well as DOCSIS link-layer DES encryption and decryption. Processor **114** receives down-

'775 Patent, 3:1-7

89

The DOCSIS MAC processor performs some of the DOCSIS MAC functionality of the cable modem.

MAC is an acronym that stands for medium access control. MAC functions relate to how the cable modem accesses the cable television network.

'775 PATENT: CABLE MODEM ARCHITECTURE

DOCSIS Controller

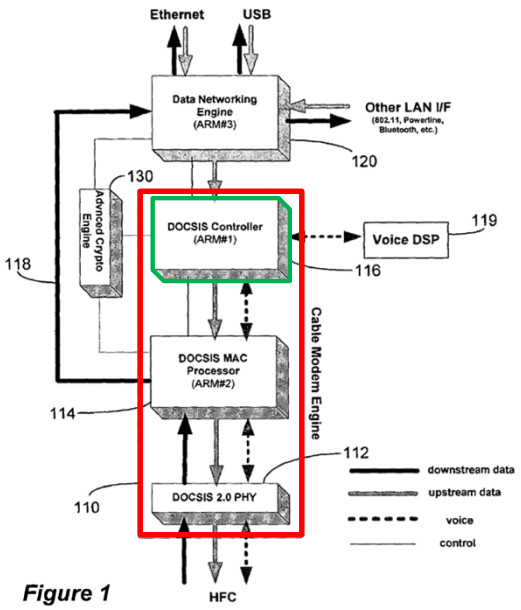


Figure 1

Controller **116** receives US PDU packets from data networking engine **120**. As previously described, DS PDU packets are forwarded by processor **114** to data networking engine **120** without involvement of controller **116**. In one implementation, controller **116** is an ARM940-based RISC processor. Controller **116** implements the following DOCSIS (blocks **200-212**) functions: MAC management message (MMM) processing (ranging, registration, UCD, UCC, DCC, DCI, UP-DIS, DSx and BPI+) (functional block **200** of FIG. **2**), IGMP, MAC address learning, classification, US protocol filtering (functional block **202** of FIG. **2**) and CM IP stack and software downloading. Functional block **204** carries out cable modem IP/UDP functions, functional block **206** carries out SNMP, DHCP, TFTP and TOD functionality and functional block **208** is responsible for cable modem provisioning. Controller **116** also includes a data network engine driver **210** in communication with data network engine **120** and cable MAC driver **212**.

In addition, in order to minimize the latency and jitter of voice packets, controller **116** also implements all PacketCable functionality. In FIG. **2**, PacketCable functionality is represented by functional blocks **220-228**. These PacketCable functions include provisioning (block **220**), security and signaling. Functional blocks **222** (voice DSP driver), **224** (streamlined IP/UDP/RTP with classification; PHS, IP/LLC filtering) and **226** (voice MAC driver) interface with external voice DSP **119**. Additionally MGCP and RTCP functions are provided by functional block **228**.

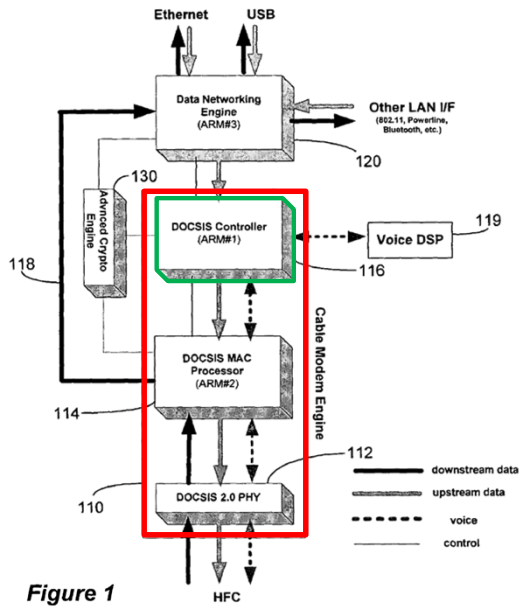
'775 Patent, 3:21-48

90

Finally, there is the DOCSIS controller. According to the specification, the DOCSIS controller performs a large number of functions, as indicated by the specification excerpts we include on this slide.

'775 PATENT: CABLE MODEM ARCHITECTURE

DOCSIS Controller



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'775 Patent, 3:21-48

91

Among the functions performed by the DOCSIS Controller are a number of DOCSIS MAC functions. These include MAC management message processing, MAC address learning, and voice MAC driver functions.

So although the cable modem engine includes a so-called DOCSIS MAC processor, the DOCSIS MAC processor does not perform all of the DOCSIS MAC functions of the cable modem. The DOCSIS controller performs a number of DOCSIS MAC functions as well.

'775 PATENT: CABLE MODEM ARCHITECTURE

Data Networking Engine

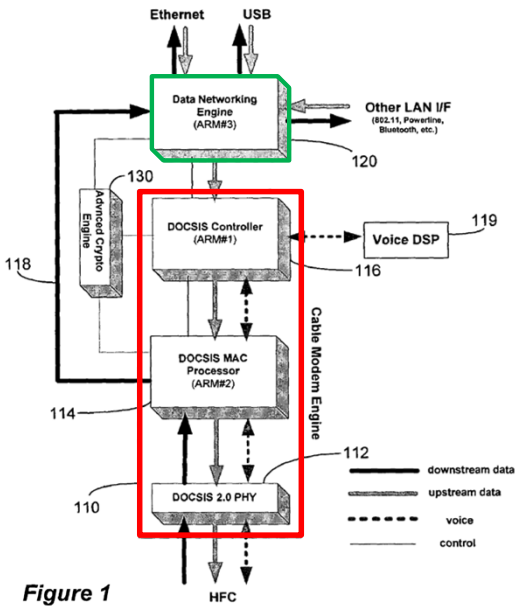

Figure 1

92

Now in addition to the cable modem engine, this cable modem architecture also includes a so-called data networking engine. We annotate that in green on this slide.

'775 PATENT: CABLE MODEM ARCHITECTURE

Data Networking Engine

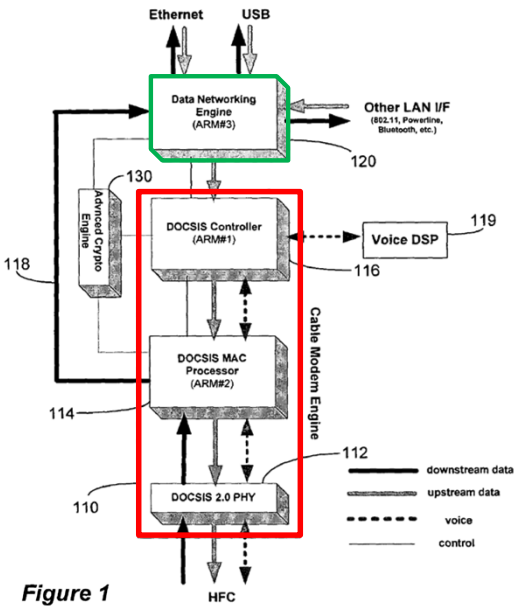

Figure 1

processing and home networking applications. The data networking engine is completely decoupled from the cable modem engine. In one implementation, the VoIP functional-

'775 Patent, 2:13-15

93

The data networking engine is said to be completely decoupled from the cable modem engine.

CABLE MODEM ARCHITECTURE

'775 Patent
Distribution of Functions Among Different Processors

94

As I'll discuss now, an important aspect of the disclosed cable modem architecture is the distribution of functions among different processors within the cable modem.

'775 PATENT: CABLE MODEM ARCHITECTURE

Cable Modem Processors

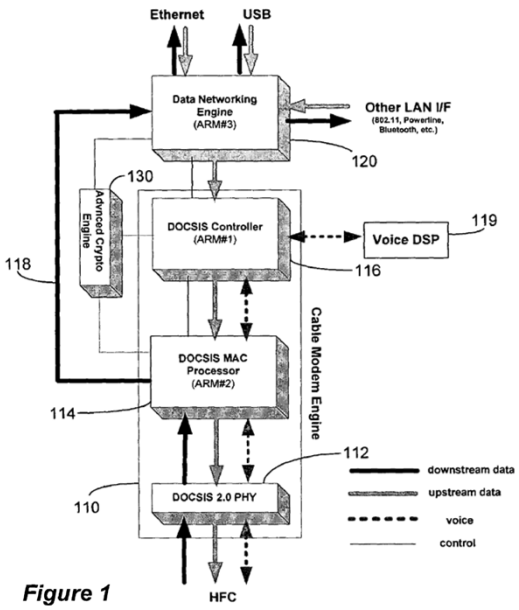

Figure 1

enhanced by the pipe-lining nature of system **100**: the processing-intensive functions of the cable modem and data networking are rationally distributed among three different processors: DOCSIS MAC processor **114** (ARM #2); DOCSIS controller **116** (ARM #1); and data networking engine **120** (ARM #3), according to their orders in the packet flow. To

'775 Patent, 4:44-49

95

As the specification explains, the objectives of the invention are achieved by distributing the functions of the cable modem among three different processors. Each of these processors is an ARM processor, which is one type of processor known in the art.

'775 PATENT: CABLE MODEM ARCHITECTURE

Cable Modem Processors

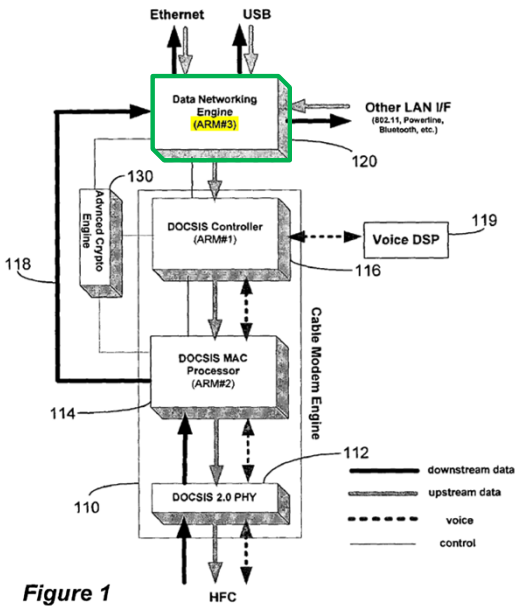

Figure 1

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'775 Patent, 4:44-49

96

The data networking engine is one of the 3 ARM processors.

In both figure 1 and in the specification, the data networking engine is identified as being ARM processor number 3.

The inventors designated this to be the third of the three ARM processors within cable modem 100.

'775 PATENT: CABLE MODEM ARCHITECTURE

Cable Modem Processors

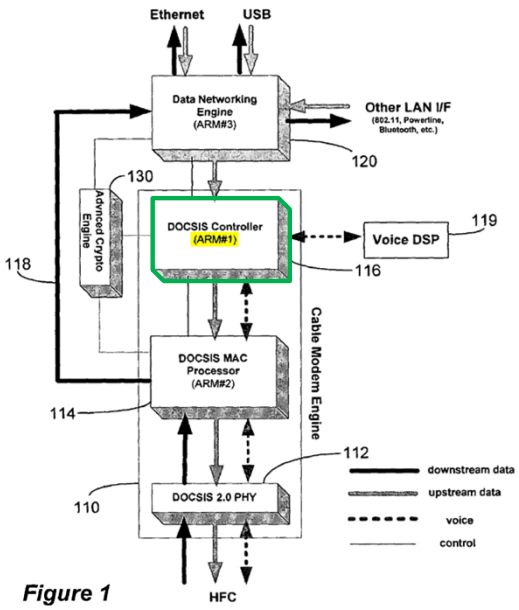


Figure 1

enhanced by the pipe-lining nature of system **100**: the processing-intensive functions of the cable modem and data networking are rationally distributed among three different processors: DOCSIS MAC processor **114** (ARM #2); DOCSIS controller **116** (ARM #1); and data networking engine **120** (ARM #3), according to their orders in the packet flow. To

'775 Patent, 4:44-49

97

The DOCSIS controller is another one of the three ARM processors within the cable modem. The inventors designated the DOCSIS controller as ARM processor number 1.

'775 PATENT: CABLE MODEM ARCHITECTURE

Cable Modem Processors

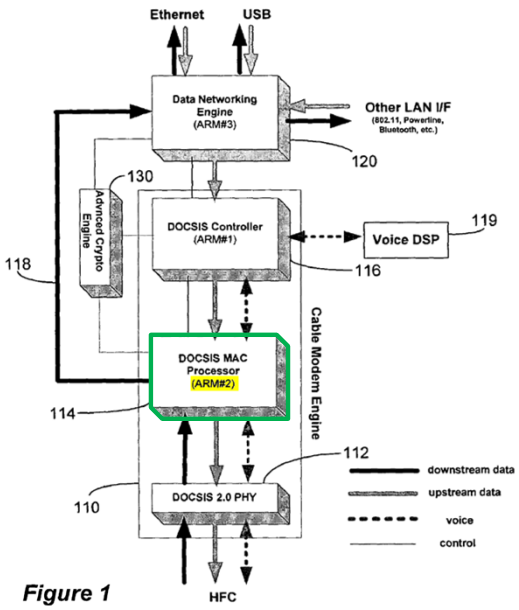


Figure 1

enhanced by the pipe-lining nature of system **100**: the processing-intensive functions of the cable modem and data networking are rationally distributed among three different processors: DOCSIS MAC processor **114** (ARM #2); DOCSIS controller **116** (ARM #1); and data networking engine **120** (ARM #3), according to their orders in the packet flow. To

'775 Patent, 4:44-49

98

Finally, the DOCSIS MAC processor is the last disclosed ARM processor within cable modem 100. The inventors designated the DOCSIS MAC processor as ARM processor number 2.

CABLE MODEM ARCHITECTURE

'775 Patent
Data Flow Within Cable Modem

99

Another important aspect of the disclosed cable modem architecture is the way data flows through the cable modem. We will discuss that now.

'775 PATENT: CABLE MODEM ARCHITECTURE

Data Flow Within CME

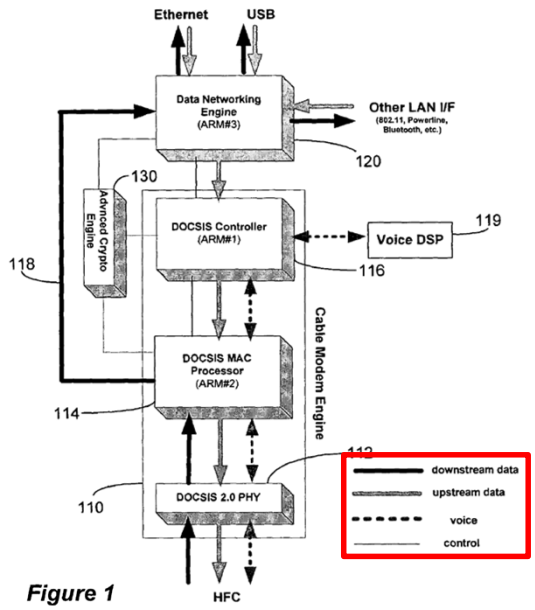


Figure 1

100

Figure 1 of the 775 patent includes a legend explaining how the different kinds of data that flow through cable modem 100 will be represented.

As indicated by the legend, voice is represented by a dashed line, upstream data by a thick grey line and downstream data by a thick black line.

'775 PATENT: CABLE MODEM ARCHITECTURE

Data Flow Within CME

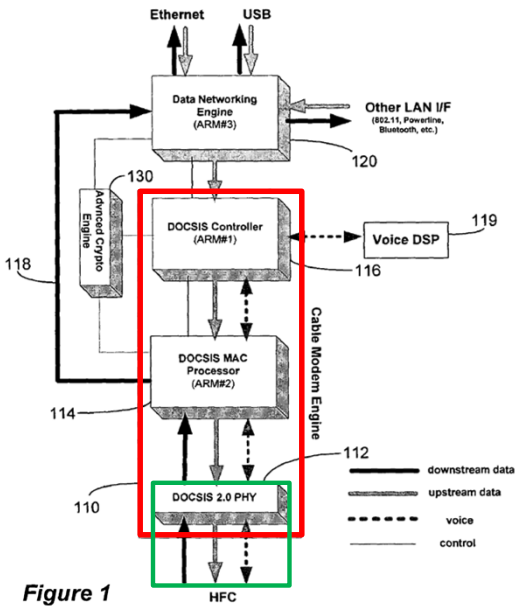


Figure 1

As seen in FIG. **1**, DOCSIS PHY layer **112** receives downstream data, transmits upstream data and receives and transmits voice data from/to an external source. In one implemen-

'775 Patent, 2:61-63

101

As we see in figure 1 then, in the portion we annotated in green, all upstream and downstream voice and other data goes through the DOCSIS 2.0 PHY.

The specification spells this out as well.

'775 PATENT: CABLE MODEM ARCHITECTURE

Data Flow Within Cable Modem

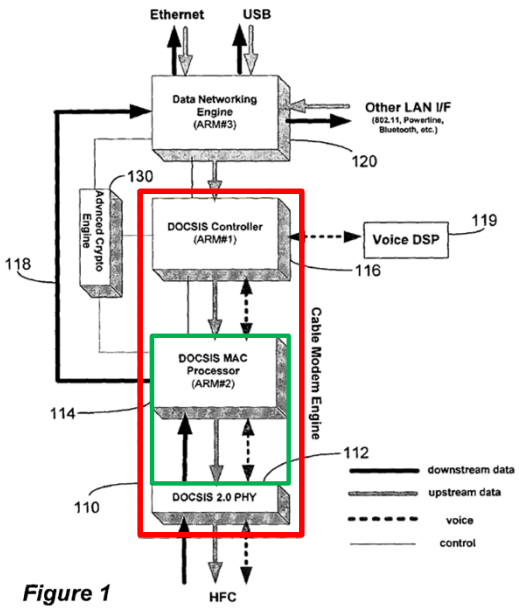


Figure 1

encryption and decryption. Processor **114** receives downstream data from, provides upstream data to and exchanges voice data in both directions with DOCSIS PHY **112**. It also

'775 Patent, 3:7-9

102

Similarly, all upstream and downstream voice and other data also goes through the DOCSIS MAC Processor.

'775 PATENT: CABLE MODEM ARCHITECTURE

Data Flow Within CME

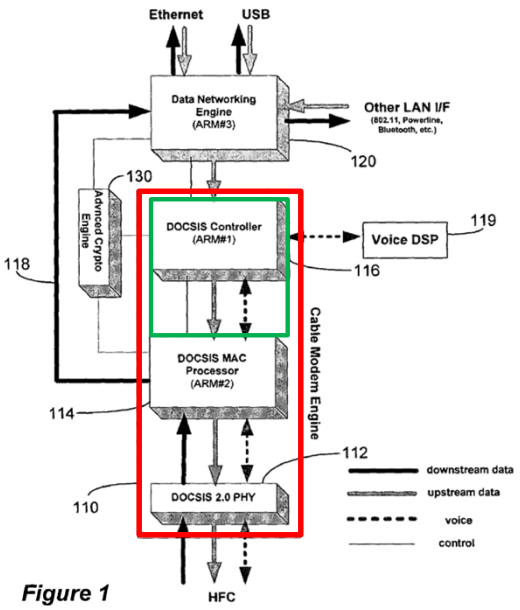


Figure 1

voice data in both directions with DOCSIS PHY **112**. It also receives upstream data from, and exchanges voice data in both directions with, controller **116**. To increase downstream

'775 Patent, 3:9-11

103

Notice on this slide, however, that while all voice goes through the DOCSIS controller, only upstream data goes through the DOCSIS controller. Downstream data is not sent by the DOCSIS MAC Processor to the DOCSIS controller.

'775 PATENT: CABLE MODEM ARCHITECTURE

Data Flow Within CME

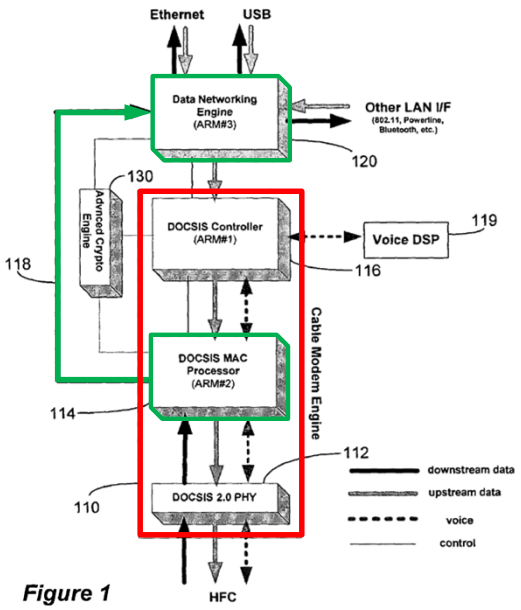


Figure 1

both directions with, controller **116**. To increase downstream throughput, all processing of DS PDU (protocol data unit) packets is done within processor **114** without involving controller **116**. After being processed, DS PDU packets are forwarded by processor **116** directly to data networking engine **120** along path **118**, bypassing controller **116**. In one imple-

'775 Patent, 3:11-16

(ARM #3), according to their orders in the packet flow. To further boost downstream throughput, the downstream PDU packets are directly forwarded from the DOCSIS MAC processor **114** to the data networking engine **120** without going through DOCSIS controller **116**. This is made possible by exploiting the asymmetric nature of the DOCSIS US/DS **152** and **154**. In addition, the data path for voice packets is laid

'775 Patent, 4:49-55

104

Instead, the DOCSIS MAC processor sends downstream data directly to the data networking engine, bypassing the DOCSIS controller completely.

This ability to bypass the DOCSIS controller is described in the specification as being important to achieving the performance objectives of the cable modem architecture. That concludes our discussion of the 775 patent. We will not address the claims of the 775 patent because Charter contends those claims are indefinite, and that it is not possible to understand what those claims cover.

RECEIVER DETERMINED PROBE

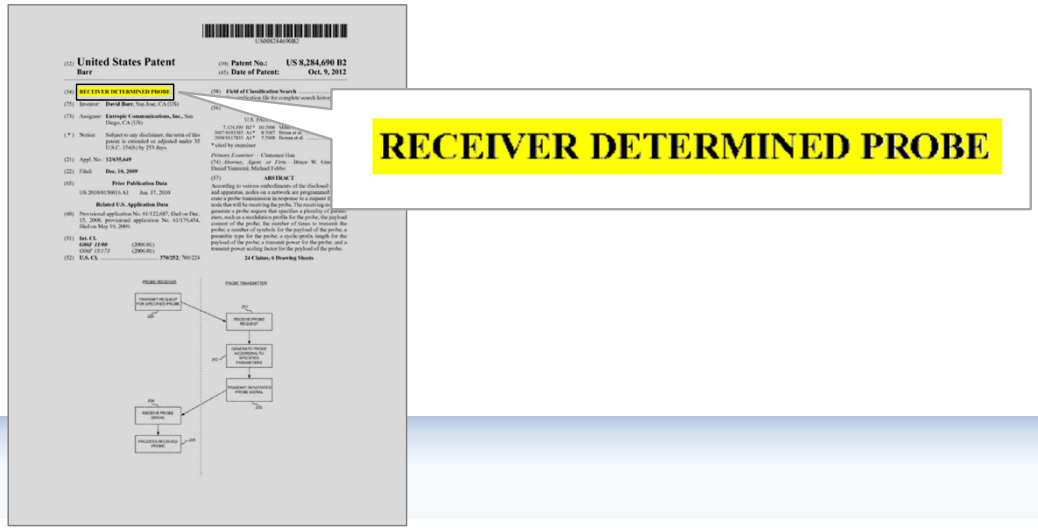
'690 Patent

105

So now we'll turn now to the 690 patent.

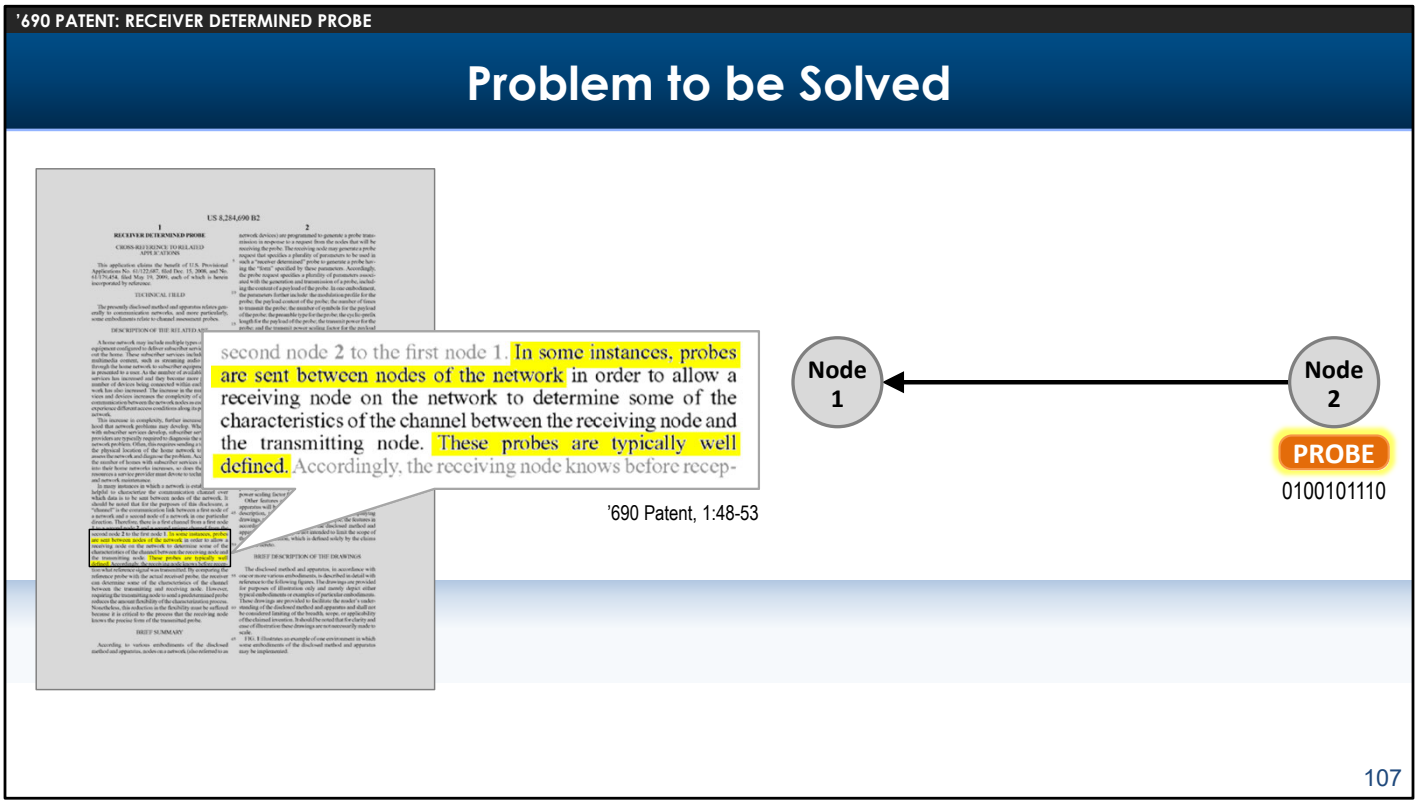
'690 PATENT: RECEIVER DETERMINED PROBE

'690 Patent: "Receiver Determined Probe"



106

I mentioned earlier that the 690 patent is directed to a Receiver determined probe. Now I'll explain what that means.

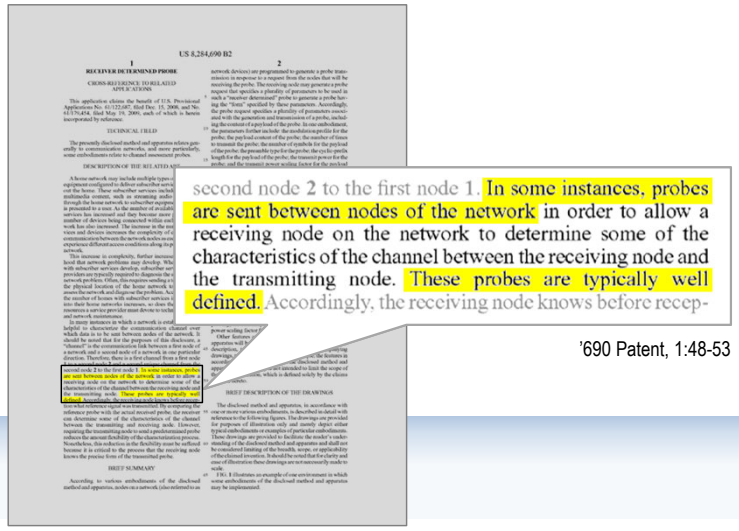


As the specification explains, it was known in the prior art for nodes on a network to send probes to one another. These probes included a known pattern which, at least according to the specification, were always defined in advance.

In the example we provide on this slide, the probe includes a predefined bit pattern of zeros and ones.

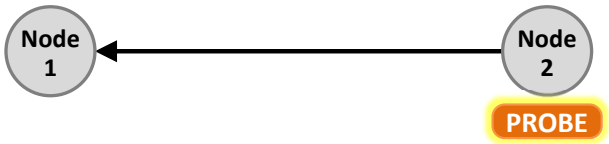
'690 PATENT: RECEIVER DETERMINED PROBE

Problem to be Solved



second node 2 to the first node 1. In some instances, probes are sent between nodes of the network in order to allow a receiving node on the network to determine some of the characteristics of the channel between the receiving node and the transmitting node. These probes are typically well defined. Accordingly, the receiving node knows before recep-

'690 Patent, 1:48-53

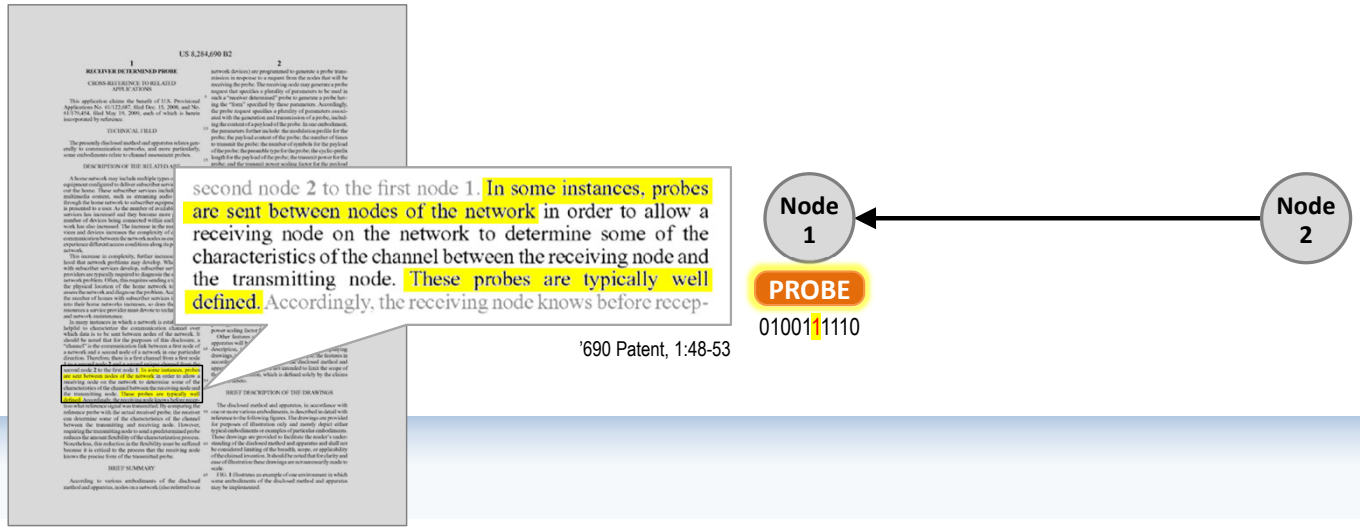


108

Here we show the probe being transmitted from node 2 to node 1.

'690 PATENT: RECEIVER DETERMINED PROBE

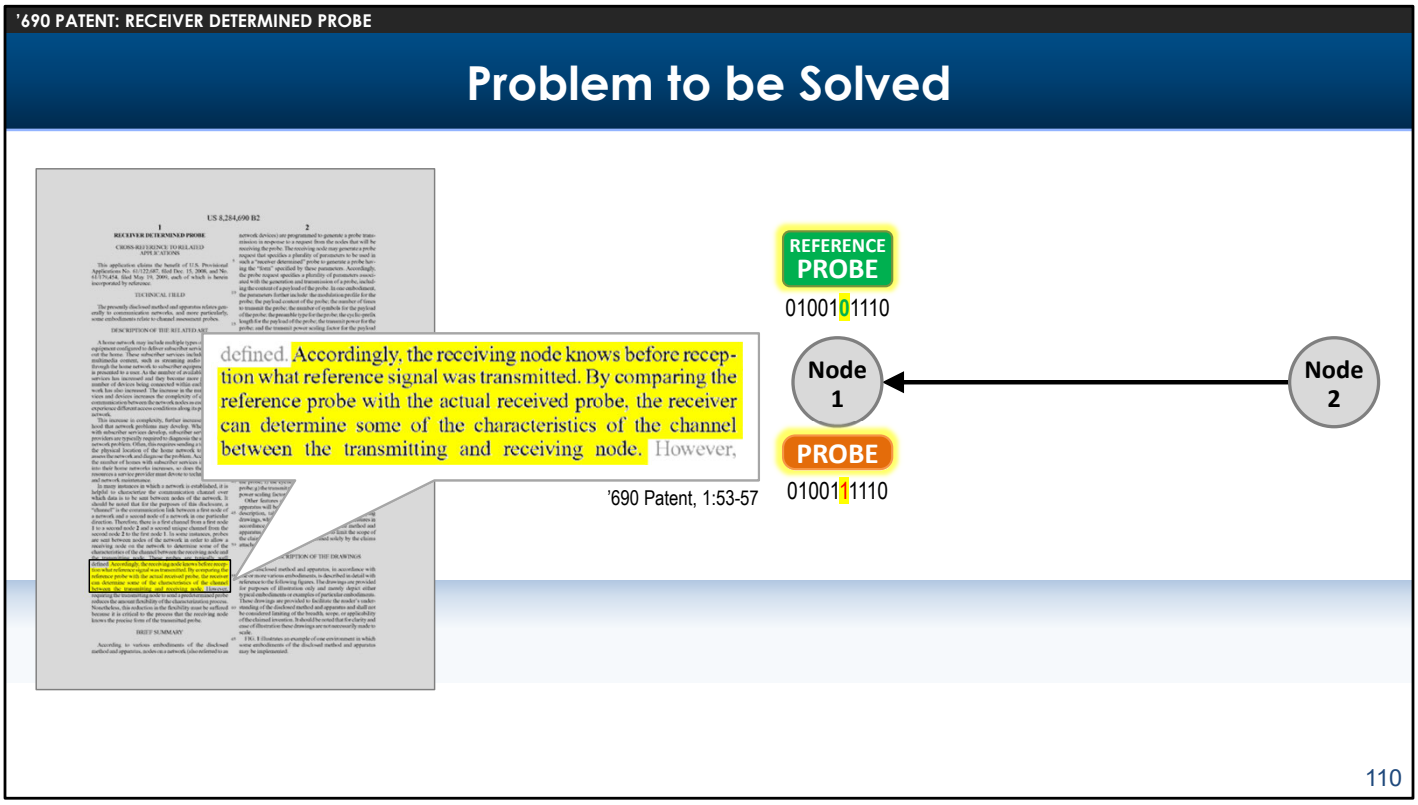
Problem to be Solved



109

Now during that transmission, problems with the communications channel can cause the probe to get corrupted.

In this example, the red probe bit highlighted in yellow was changed during transmission from a 0 to a 1.

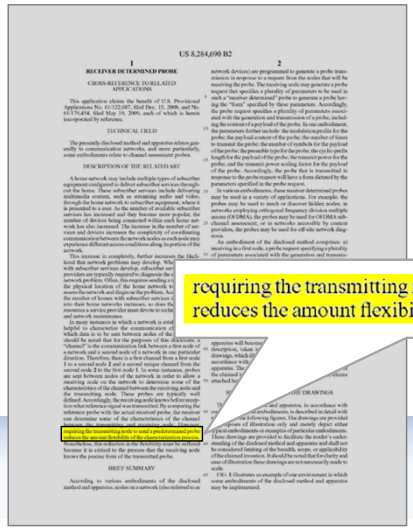


Because the probes are defined in advance, however, the node that received the probe knows the pattern it was supposed to receive. It has a reference probe to compare to the probe it actually received.

As the specification explains, by examining the difference between the reference probe and the probe it actually received, the receiving node can determine characteristics of the channel over which the probe was transmitted.

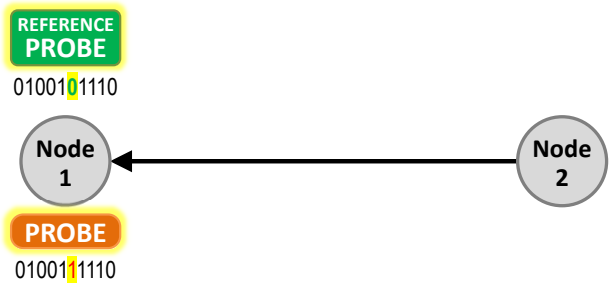
'690 PATENT: RECEIVER DETERMINED PROBE

Problem to be Solved



requiring the transmitting node to send a predetermined probe reduces the amount flexibility of the characterization process.

'690 Patent, 1:58-59



111

According to the specification, however, the requirement that the probes be predefined limits the ability of the receiving node to determine characteristics of the channel.

'690 PATENT: RECEIVER DETERMINED PROBE

Receiver Determined Probe

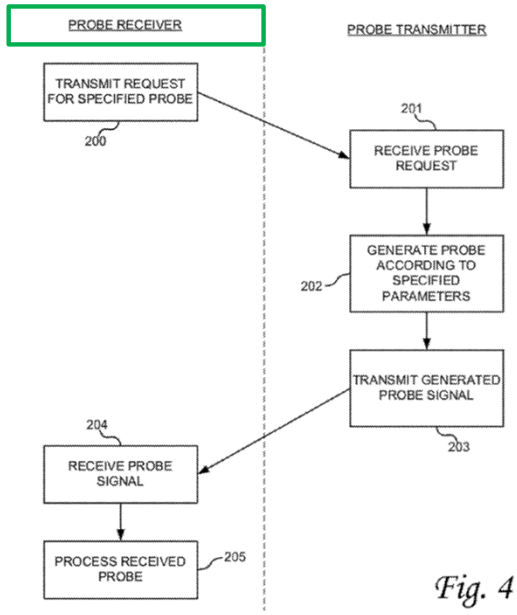


Fig. 4

112

That's where the alleged invention of the 690 patent comes in. The patent is directed to a receiver determined probe, whereby the node that will receive the probe determines what the form of the probe will be.

The patent explains this with respect to Figure 4, where the node that will receive the probe is called the probe receiver.

'690 PATENT: RECEIVER DETERMINED PROBE

Receiver Determined Probe

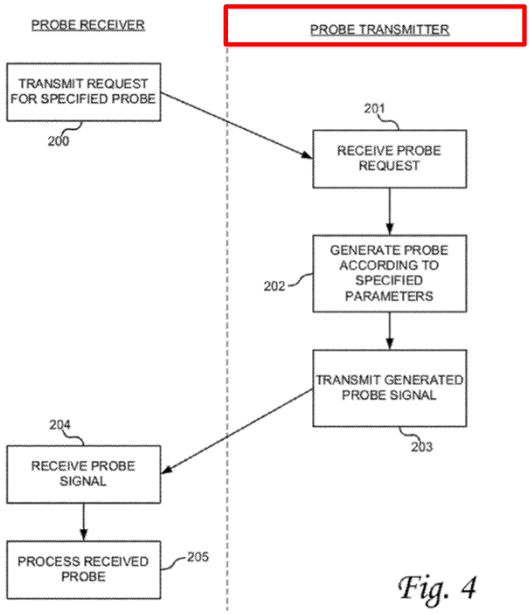


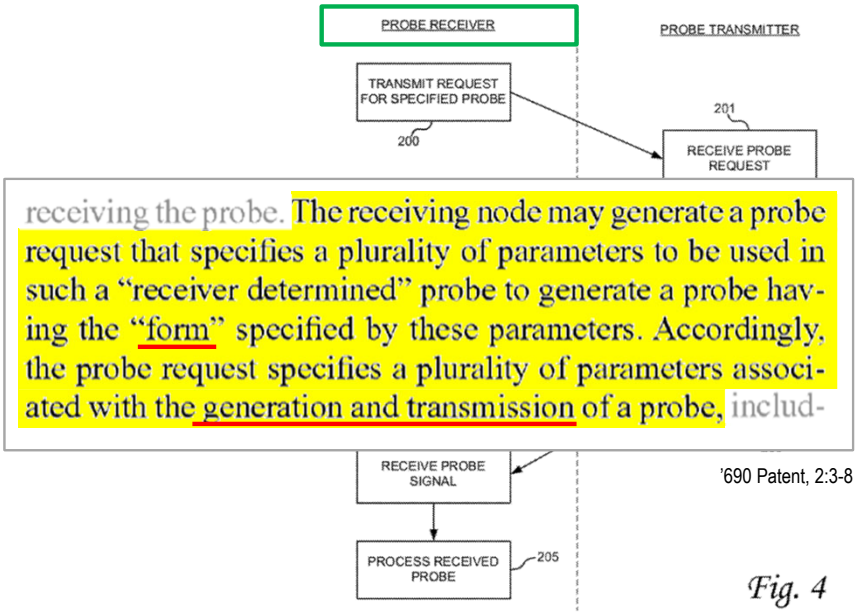
Fig. 4

113

And the node that will generate and transmit the probe is called the probe transmitter.

'690 PATENT: RECEIVER DETERMINED PROBE

Receiver Determined Probe



receiving the probe. The receiving node may generate a probe request that specifies a plurality of parameters to be used in such a "receiver determined" probe to generate a probe having the "form" specified by these parameters. Accordingly, the probe request specifies a plurality of parameters associated with the generation and transmission of a probe, includ-

'690 Patent, 2:3-8

Fig. 4

114

According to the specification, the probe receiver specifies parameters that dictate the "form" of the probe it wants to receive. Those parameters dictate how the probe will be generated and transmitted by the probe transmitter.

'690 PATENT: RECEIVER DETERMINED PROBE

Probe Request

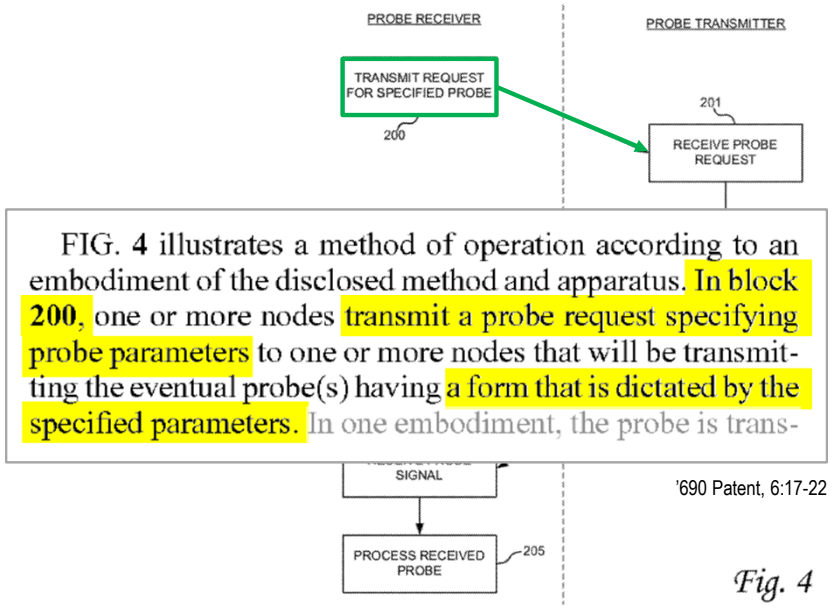


FIG. 4 illustrates a method of operation according to an embodiment of the disclosed method and apparatus. In block 200, one or more nodes transmit a probe request specifying probe parameters to one or more nodes that will be transmitting the eventual probe(s) having a form that is dictated by the specified parameters. In one embodiment, the probe is trans-

'690 Patent, 6:17-22

Fig. 4

115

So let's review how this works with reference to Figure 4

First, at block 200, the Probe receiver transmits a probe request to the probe transmitter. The probe request contains parameters that dictate the form of the probe to be generated and transmitted by the probe transmitter.

'690 PATENT: RECEIVER DETERMINED PROBE

Probe Request Parameters

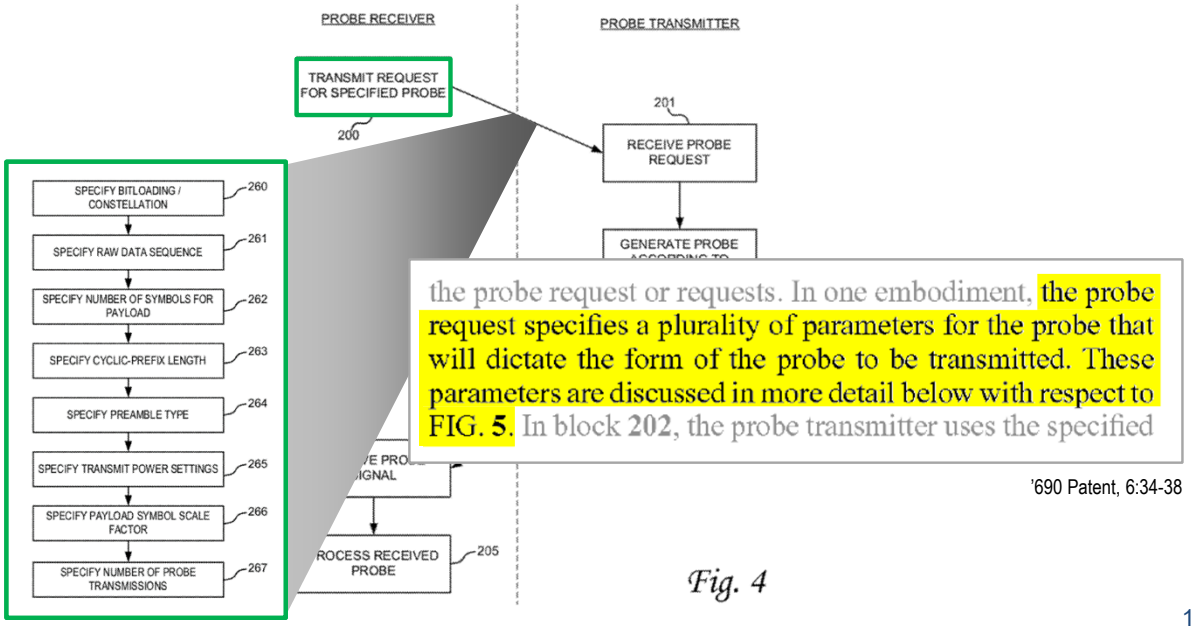


Fig. 5

the probe request or requests. In one embodiment, the probe request specifies a plurality of parameters for the probe that will dictate the form of the probe to be transmitted. These parameters are discussed in more detail below with respect to FIG. **5**. In block **202**, the probe transmitter uses the specified

'690 Patent, 6:34-38

Fig. 4

116

The parameters contained in the probe request which dictate the form of the probe are said to be depicted in figure 5.

'690 PATENT: RECEIVER DETERMINED PROBE

Probe Transmitter

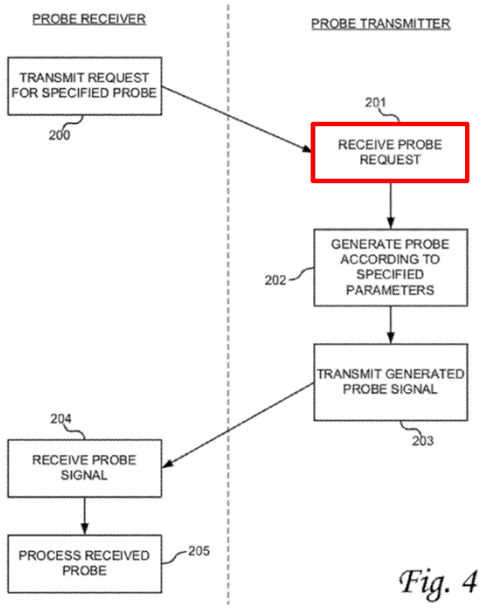


Fig. 4

117

The probe transmitter receives the probe request in block 201.

'690 PATENT: RECEIVER DETERMINED PROBE

Probe Transmitter

FIG. 5. In block **202**, the probe transmitter uses the specified probe parameters to generate a probe having a form that complies with the specified parameters. In block **203**, the

'690 Patent, 6:38-40

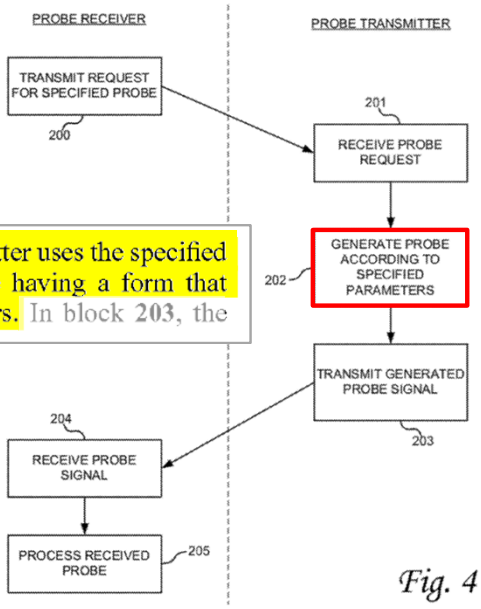


Fig. 4

118

And in block 202, it generates the probe in accordance with the parameters it received in the probe request.

'690 PATENT: RECEIVER DETERMINED PROBE

Probe Transmitter

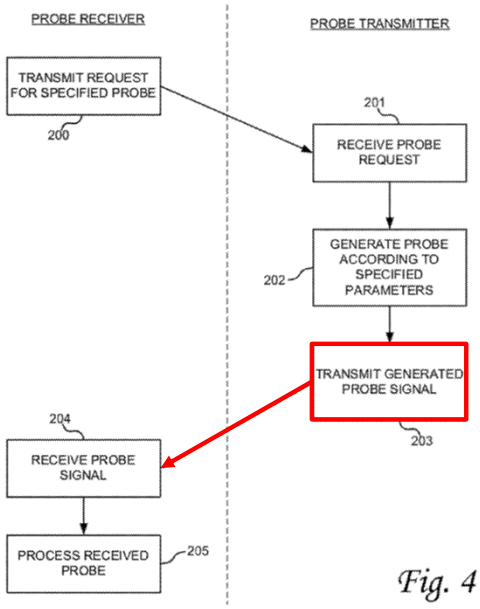


Fig. 4

119

It then transmits the probe it generated to the probe receiver

'690 PATENT: RECEIVER DETERMINED PROBE

Probe Receiver

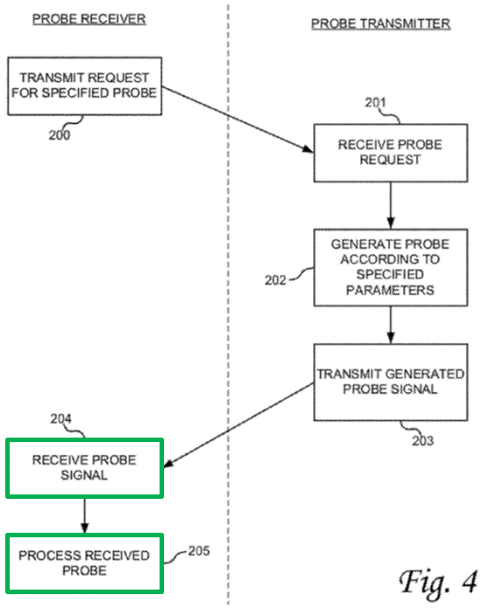


Fig. 4

120

After which the probe receiver receives and processes the probe in blocks 204 and 205.

That concludes our discussion of the 690 patent. Again, we will not address the claims of the 690 patent because Charter contends those claims are indefinite and that it is not possible to understand what those claims cover.

SERVICE GROUP ASSIGNMENTS

’682 Patent

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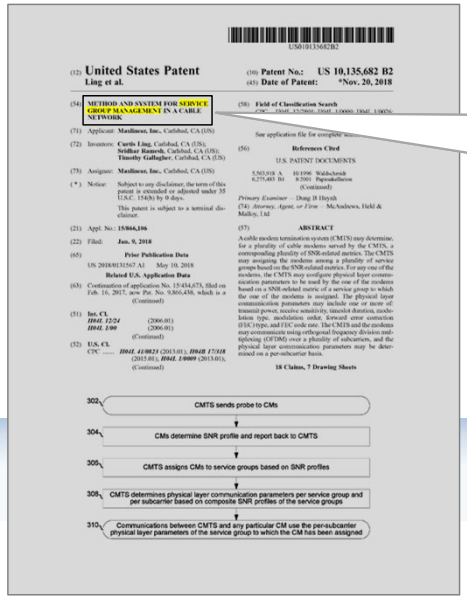
Finally, the last of the asserted patents is the 682 patent.

'682 PATENT: SERVICE GROUP ASSIGNMENTS

'682 Patent



(12) United States Patent
Ling et al.

(10) Patent No.: US 10,135,682 B2
(45) Date of Patent: *Nov. 20, 2018

(54) METHOD AND SYSTEM FOR SERVICE GROUP MANAGEMENT IN A CABLE NETWORK

(71) Applicant: Maxlinear, Inc., Carlsbad, CA (US)

(72) Inventors: Curtis Ling, Carlsbad, CA (US); Sridhar Ramesh, Carlsbad, CA (US); Timothy Gallagher, Carlsbad, CA (US)

(73) Assignee: Maxlinear, Inc., Carlsbad, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: 15/866,106

(22) Filed: Jan. 9, 2018

(65) Prior Publication Data

US 2018/0131567 A1 May 10, 2018

Related U.S. Application Data

(63) Continuation of application No. 15/434,673, filed on Feb. 16, 2017, now Pat. No. 9,866,438, which is a (Continued)

(51) Int. Cl.
H04L 12/24 (2006.01)
H04L 1/00 (2006.01)
(Continued)

(52) U.S. Cl.
CPC *H04L 41/0823* (2013.01); *H04B 17/318* (2015.01); *H04L 1/0009* (2013.01);
(Continued)

(58) Field of Classification Search

See application file for complete search

(56) References Cited

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5,563,918 A 10/1996 Waldschmidt
6,275,483 B1 8/2001 Papoushkhina
(Continued)

Primary Examiner — Dung B Huynh
(74) Attorney, Agent, or Firm — McAndrews, Held & Malloy, Ltd

(57) ABSTRACT

A cable modem termination system (CMTS) may determine, for a plurality of cable modems served by the CMTS, a corresponding plurality of SNR-related metrics. The CMTS may assigning the modems among a plurality of service groups based on the SNR-related metrics. For any one of the modems, the CMTS may configure physical layer communication parameters to be used by the one of the modems based on a SNR-related metric of a service group to which the one of the modems is assigned. The physical layer communication parameters may include one or more of: transmit power, receive sensitivity, timeslot duration, modulation type, modulation order, forward error correction (FEC) type, and FEC code rate. The CMTS and the modems may communicate using orthogonal frequency division multiplexing (OFDM) over a plurality of subcarriers, and the physical layer communication parameters may be determined on a per-subcarrier basis.

18 Claims, 7 Drawing Sheets

302 CMTS sends probe to CMs
304 CMs determine SNR profile and report back to CMTS
306 CMTS assigns CMs to service groups based on SNR profiles
308 CMTS determines physical layer communication parameters per service group and per subcarrier based on composite SNR profiles of the service groups
310 Communications between CMTS and any particular CM use the per-subcarrier physical layer parameters of the service group to which the CM has been assigned

METHOD AND SYSTEM FOR SERVICE GROUP MANAGEMENT IN A CABLE NETWORK

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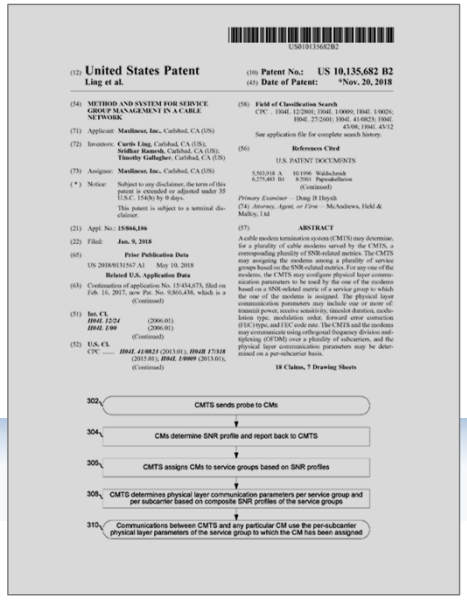
As the title suggests, this patent discloses an allegedly novel way of assigning cable modems to service groups.

'682 PATENT: SERVICE GROUP ASSIGNMENTS

Problem To Be Solved



(12) **United States Patent**
Ling et al.

(10) **Patent No.: US 10,135,682 B2**
(45) **Date of Patent: *Nov. 20, 2018**

(54) METHOD AND SYSTEM FOR SERVICE GROUP MANAGEMENT IN A CABLE NETWORK

(71) Applicant: **Maxlinear, Inc.**, Carlsbad, CA (US)

(72) Inventors: **Curtis Ling**, Carlsbad, CA (US); **Sridhar Ramesh**, Carlsbad, CA (US); **Timothy Gallagher**, Carlsbad, CA (US)

(73) Assignee: **Maxlinear, Inc.**, Carlsbad, CA (US)

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(51) **Int. Cl.**
H04L 12/24 (2006.01)
H04L 1/00 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H04L 41/0823*** (2013.01); ***H04B 17/318*** (2015.01); ***H04L 1/0009*** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC H04L 12/2801; H04L 1/0009; H04L 1/0026; H04L 27/2601; H04L 41/0823; H04L 43/08; H04L 43/12
See application file for complete search history.

(56) **References Cited**
U.S. PATENT DOCUMENTS

5,563,918 A 10/1996 Waldschmidt
6,275,483 B1 8/2001 Papoushkevich
(Continued)

Primary Examiner — Dung B Huynh
(74) *Attorney, Agent, or Firm* — McAndrews, Held & Malloy, Ltd

(57) **ABSTRACT**

A cable modem termination system (CMTS) may determine, for a plurality of cable modems served by the CMTS, a corresponding plurality of SNR-related metrics. The CMTS may assigning the modems among a plurality of service groups based on the SNR-related metrics. For any one of the modems, the CMTS may configure physical layer communication parameters to be used by the one of the modems based on a SNR-related metric of a service group to which the one of the modems is assigned. The physical layer communication parameters may include one or more of: transmit power, receive sensitivity, timeslot duration, modulation type, modulation order, forward error correction (FEC) type, and FEC code rate. The CMTS and the modems may communicate using orthogonal frequency division multiplexing (OFDM) over a plurality of subcarriers, and the physical layer communication parameters may be determined on a per-subcarrier basis.

18 Claims, 7 Drawing Sheets

302 CMTS sends probe to CMs
304 CMs determine SNR profile and report back to CMTS
306 CMTS assigns CMs to service groups based on SNR profiles
308 CMTS determines physical layer communication parameters per service group and per subcarrier based on composite SNR profiles of the service groups
310 Communications between CMTS and any particular CM use the per-subcarrier physical layer parameters of the service group to which the CM has been assigned

BACKGROUND OF THE INVENTION

Convention cable television networks can be inefficient and have insufficient capacity. Further limitations and disadvantages of conventional and traditional approaches will become apparent to one of skill in the art, through comparison of such systems with some aspects of the present invention as set forth in the remainder of the present application with reference to the drawings.

BRIEF SUMMARY OF THE INVENTION

A system and/or method is provided for service group management in a cable television network, substantially as

'682, Patent 1:56-67

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According to the specification, existing cable networks are inefficient and have insufficient capacity. The disclosed system and method for assigning cable modems to service groups is said to address these issues.

'682 PATENT: SERVICE GROUP ASSIGNMENTS

DOCSIS Cable Network

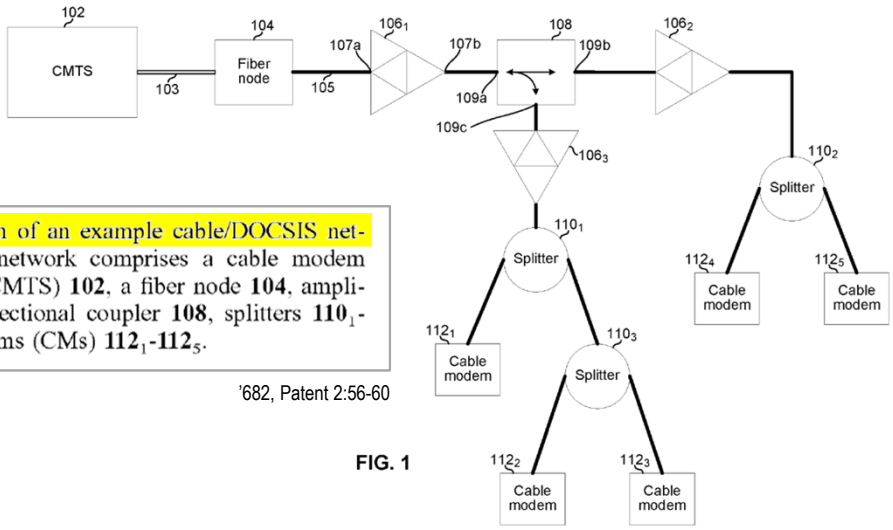

FIG. 1 is a diagram of an example cable/DOCSIS network. The example network comprises a cable modem termination system (CMTS) **102**, a fiber node **104**, amplifiers **106$_1$-106$_3$**, a directional coupler **108**, splitters **110$_1$-110$_3$**, and cable modems (CMs) **112$_1$-112$_5$**.

'682, Patent 2:56-60

FIG. 1

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An exemplary DOCSIS cable network showing cable modems to be assigned to service groups is depicted in Figure 1.

'682 PATENT: SERVICE GROUP ASSIGNMENTS

DOCSIS Cable Network

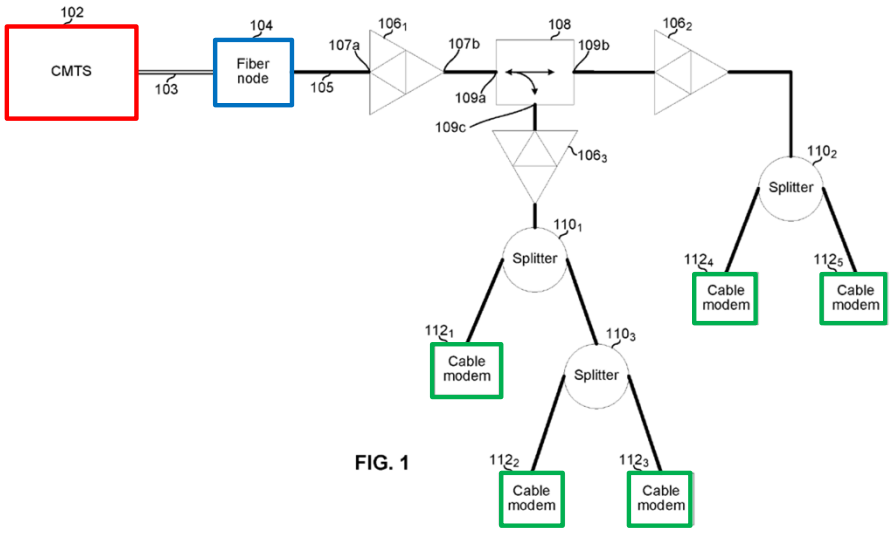

FIG. 1

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The cable modems are annotated in green. In addition, we've annotated the CMTS in red, and a device called a fiber node in blue.

'682 PATENT: SERVICE GROUP ASSIGNMENTS

Service Groups

DOCSIS Specification

Cable Modem Service Group	In the HFC plant topology, the complete set of downstream and upstream channels within a single CMTS that a single Cable Modem could potentially receive or transmit on. **In most HFC deployments, a CM-SG corresponds to a single Fiber Node.** Usually, a CM-SG serves multiple CMs.

Data-Over-Cable Service Interface Specifications, DOCSIS 3.0, MAC and Upper Layers Protocols Interface Specification, CM-SPMULPIv3.0-I18-120329, at 11 (Mar. 29, 2012)

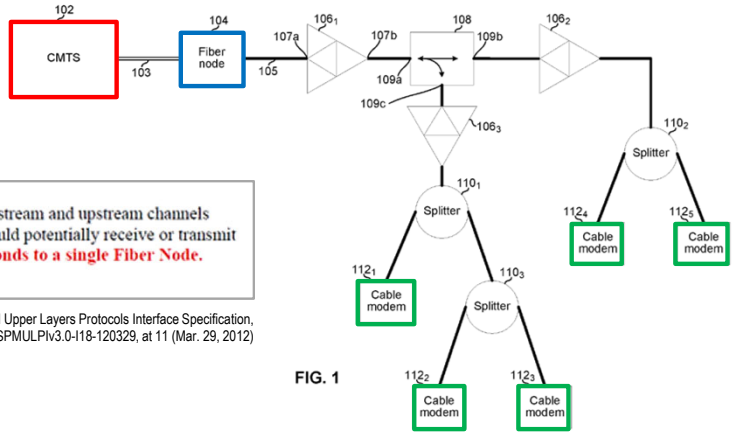

FIG. 1

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Now before we explain the disclosed method of assigning cable modems to service groups, we have to fist explain what a service group is. The term service group has a well-understood plain and ordinary meaning in the cable television art. In fact, the DOCSIS specification itself provides that definition. We have put that definition on the slide.

A cable modem service group is the complete set of downstream and upstream channels within a single CMTS that a single Cable Modem could potentially receive or transmit on. As the text in red indicates, in most but not all instances, a cable modem service group includes all of the cable modems which correspond to the same fiber node. In figure 1 of the 682 patent, that would be all of the cable modems annotated in green.

As we will see, the alleged invention purports to allow the creation of service groups whereby cable modems corresponding to the same fiber node can be in different service groups

'682 PATENT: SERVICE GROUP ASSIGNMENTS

Assigning Cable Modems To Service Groups

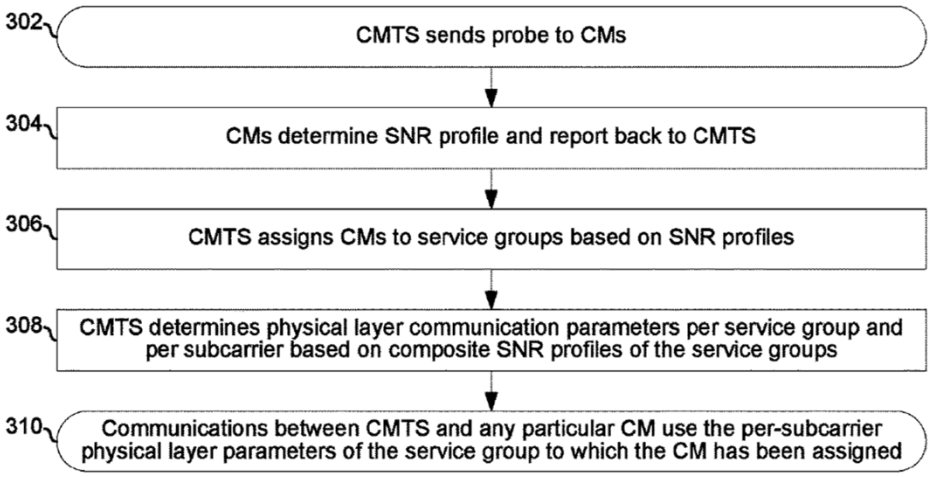

FIG. 3A

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So now I'll explain the disclosed method of assigning cable modems to service groups. Figure 3A of the patent depicts that method.

'682 PATENT: SERVICE GROUP ASSIGNMENTS

Assigning Cable Modems To Service Groups

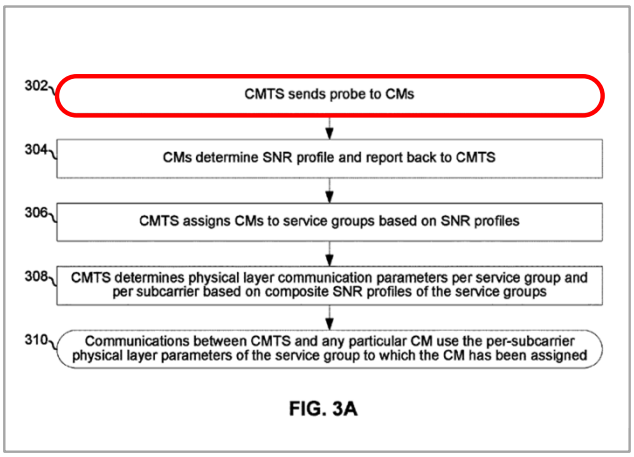

FIG. 3A

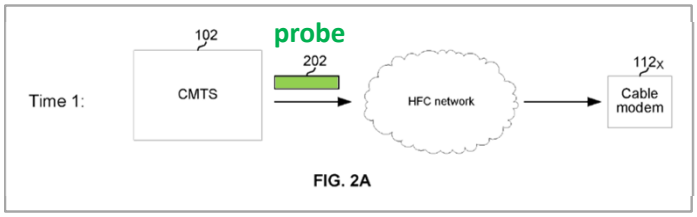

FIG. 2A

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First, the CMTS sends probes to the cable modems. This is depicted graphically in Figure 2A of the patent.

'682 PATENT: SERVICE GROUP ASSIGNMENTS

SNR Profile

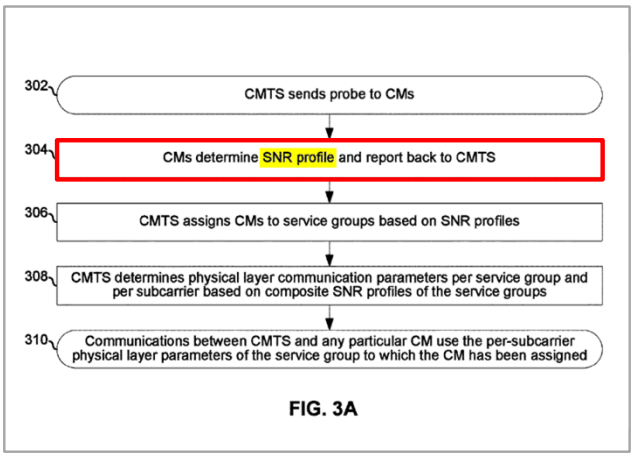

FIG. 3A

129

Each cable modem then uses the probe to determine its SNR profile.

'682 PATENT: SERVICE GROUP ASSIGNMENTS

SNR Profile

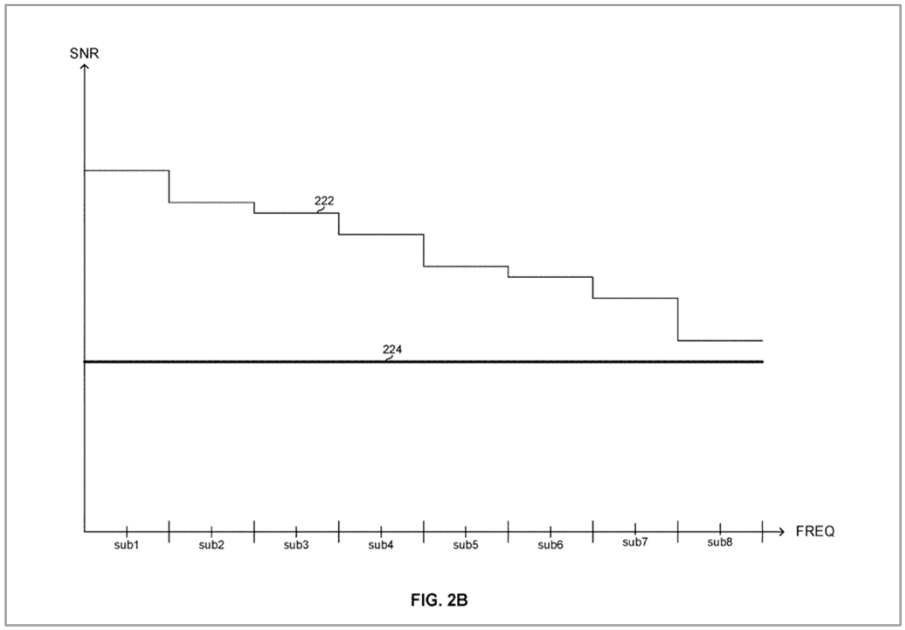

FIG. 2B

130

We'll explain what an SNR profile is with reference to Figure 2B.

'682 PATENT: SERVICE GROUP ASSIGNMENTS

SNR Profile

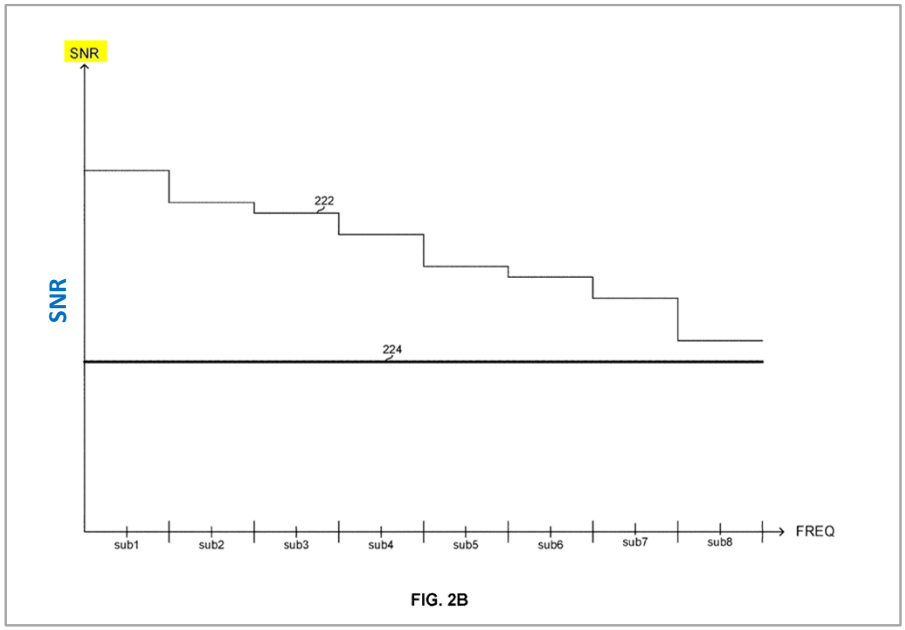

FIG. 2B

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The y-axis on Figure 2B is the SNR. SNR stands for signal to noise ratio. A signal to noise ratio is the ratio of the signal level to the noise level. The higher the SNR the greater the ratio of signal to noise. Greater signal and less noise is better, as noise interferes with the ability to understand or properly interpret the signal that is received.

'682 PATENT: SERVICE GROUP ASSIGNMENTS

SNR Profile

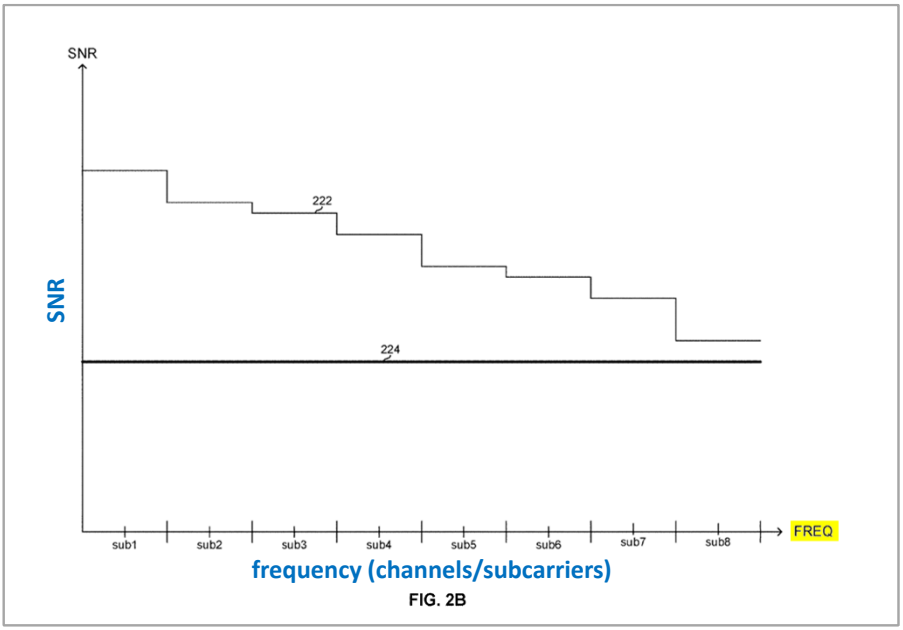

FIG. 2B

132

The x axis is frequency. Figure 2B depicts different subcarriers on the x axis which are at different frequencies. In the example of figure 2B, eight subcarriers are used which are denoted sub 1 through sub 8.

'682 PATENT: SERVICE GROUP ASSIGNMENTS

SNR Profile

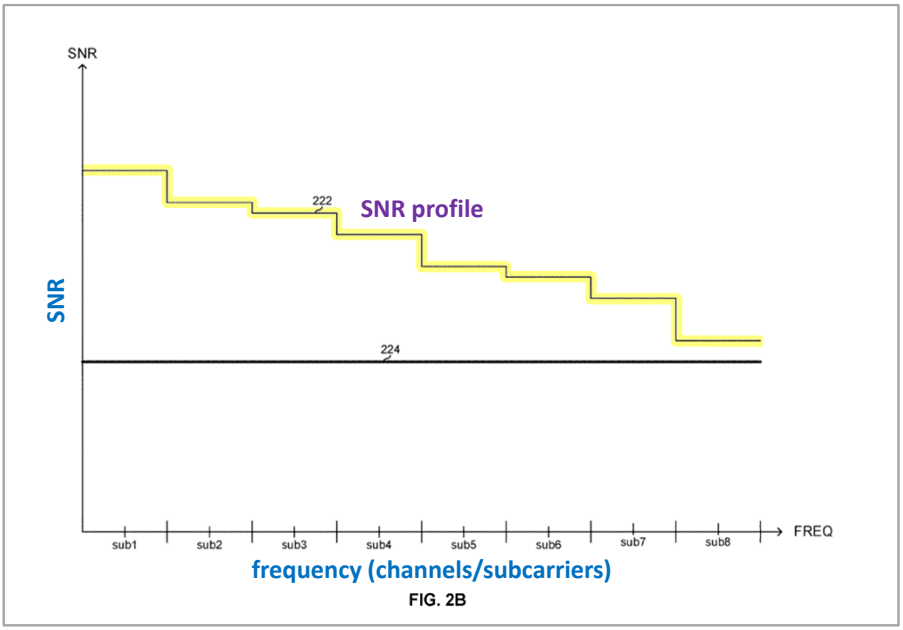

FIG. 2B

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The line labeled 222 represents the SNR at each of the subcarriers.

When a cable modem is returning its SNR profile to the CMTS, line 222 would represent the SNR of that particular cable modem at each subcarrier.

'682 PATENT: SERVICE GROUP ASSIGNMENTS

SNR Profile

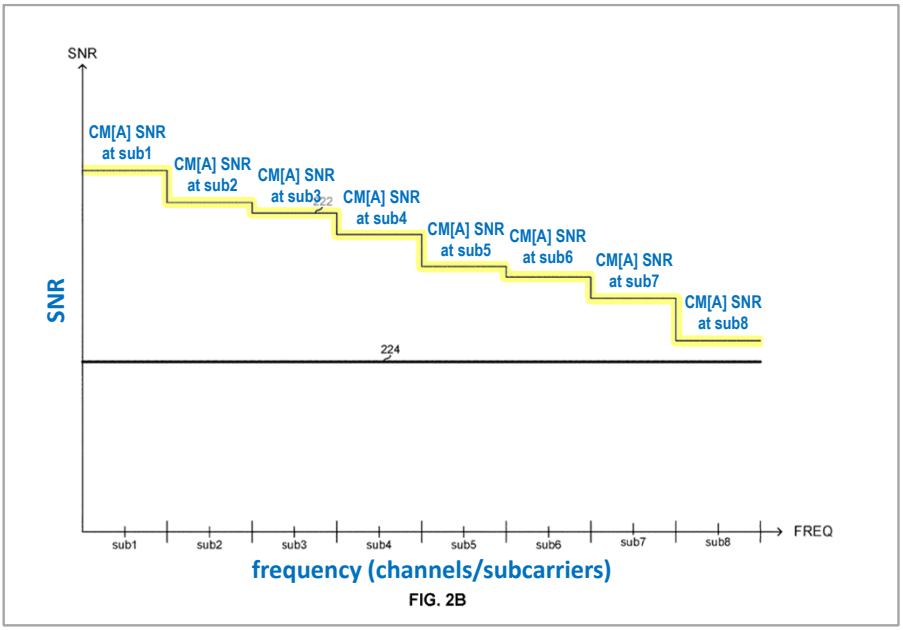


FIG. 2B

134

Thus, if a hypothetical cable modem A was returning its SNR profile to the CMTS, each step in line 222 would be the SNR of cable modem A at one of the subcarriers.

In this illustration, cable modem A is designated as C M followed by the letter A in brackets.

'682 PATENT: SERVICE GROUP ASSIGNMENTS

SNR Profile

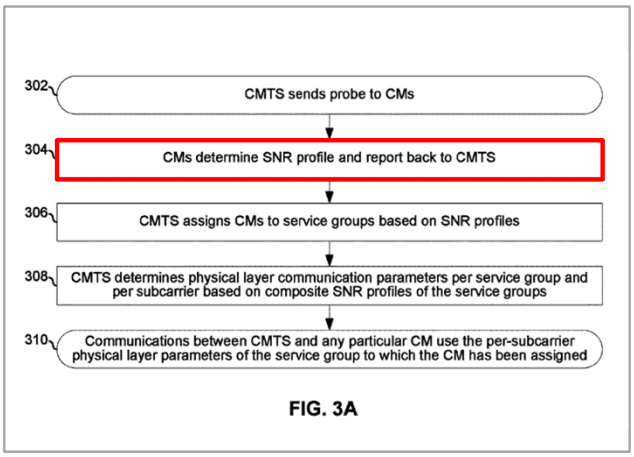
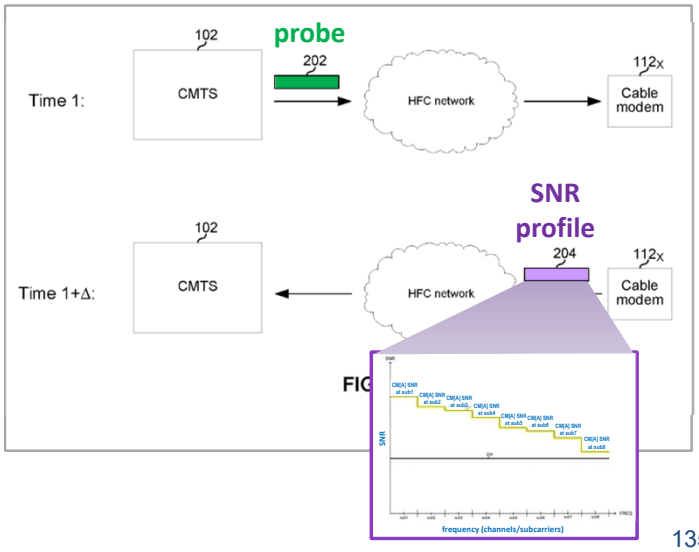


FIG. 3A



135

Next, in step 306, the CMTS uses the SNR profiles it received from all the cable modems to assign the cable modems to service groups.

'682 PATENT: SERVICE GROUP ASSIGNMENTS

Service Group Assignments

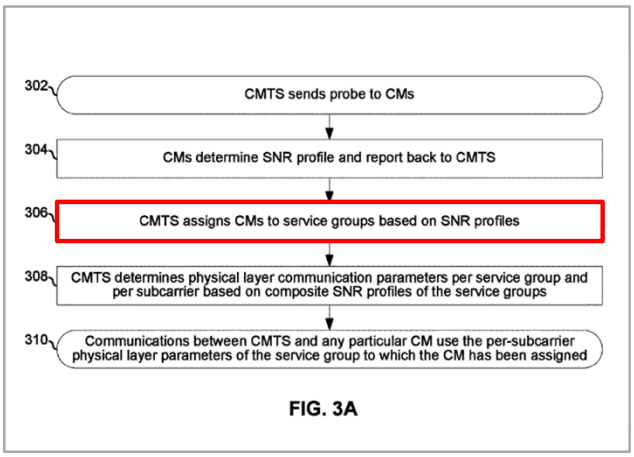


FIG. 3A

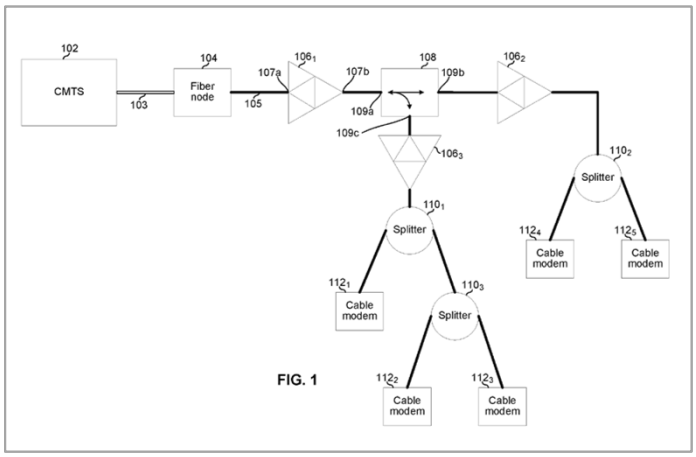


FIG. 1

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Next, in step 306, the CMTS uses the SNR profiles it received from all the cable modems to assign the cable modems to service groups.

'682 PATENT: SERVICE GROUP ASSIGNMENTS

Service Group Assignments

16-QAM on channel z. Conversely, if 112_1, 112_4, and 112_5 are assigned to a first service group and 112_2 and 112_3 are assigned to a second service group, then the first service

'682 Patent, 5:64-66

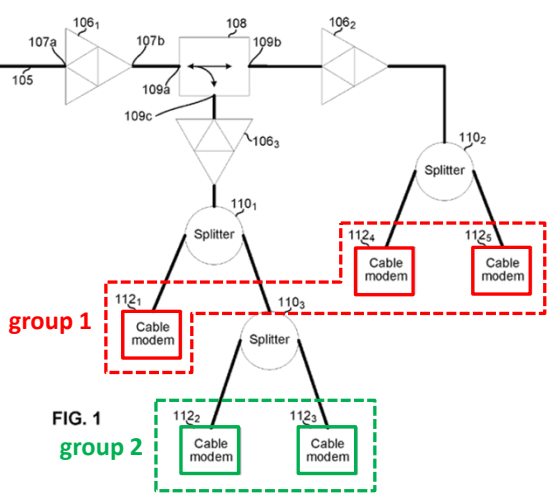

FIG. 1

137

In the example disclosed in the specification, the CMTS assigns the three cable modems annotated in red to service group 1, and the two cable modems annotated in green to service group 2.

'682 PATENT: SERVICE GROUP ASSIGNMENTS

Service Group Assignments

16-QAM on channel z. Conversely, if 112_1, 112_4, and 112_5 are assigned to a first service group and 112_2 and 112_3 are assigned to a second service group, then the first service

'682 Patent, 5:64-66

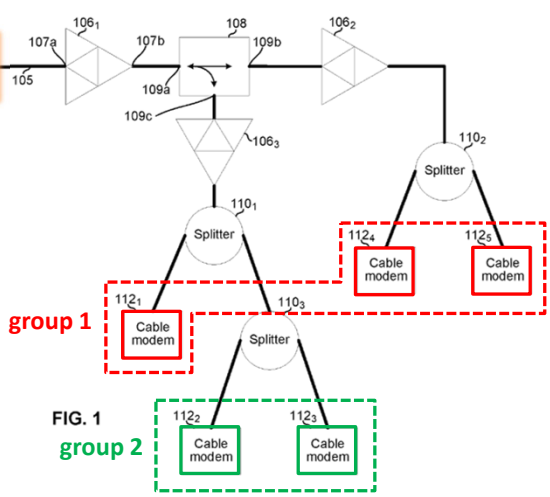

FIG. 1

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Notice that both the red and the green cable modems correspond to the same fiber node 104. Thus, the alleged invention seemingly has the capability of creating service groups whereby cable modems which correspond to the same fiber node can be in different service groups.

'682 PATENT: SERVICE GROUP ASSIGNMENTS

Composite Worst Case SNR Profile

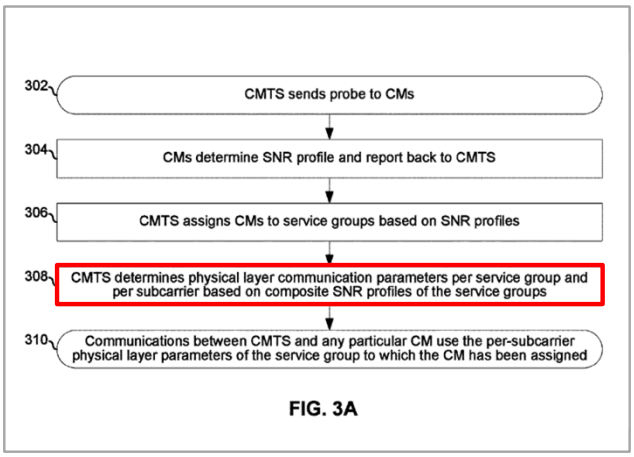

FIG. 3A

In block **308**, physical layer communication parameters are determined per service group and per channel/subcarrier. For example, for any particular service group, the modulation order and FEC code rate to be used on a particular subcarrier may be determined based on the worst case SNR for that subcarrier among the CMs in that particular service group. Thus, it can be seen that grouping CMs based on SNR

'682 Patent, 5:40-46

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Next, once the cable modems have been assigned to service groups, the CMTS determines parameters for communicating with each different service group in step 308. It does that by using a composite worst-case SNR profile for each service group.

As the specification explains in the excerpt on the slide now, a composite worst case SNR profile for a service group is the worst case SNR at each subcarrier among the cable modems in the service group.

'682 PATENT: SERVICE GROUP ASSIGNMENTS

Composite Worst Case SNR Profile

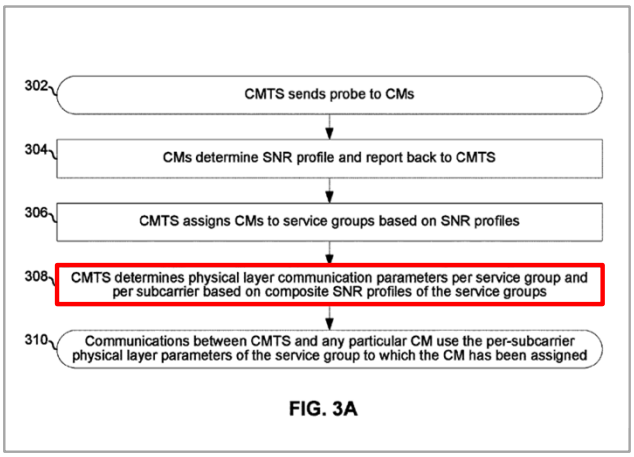

FIG. 3A

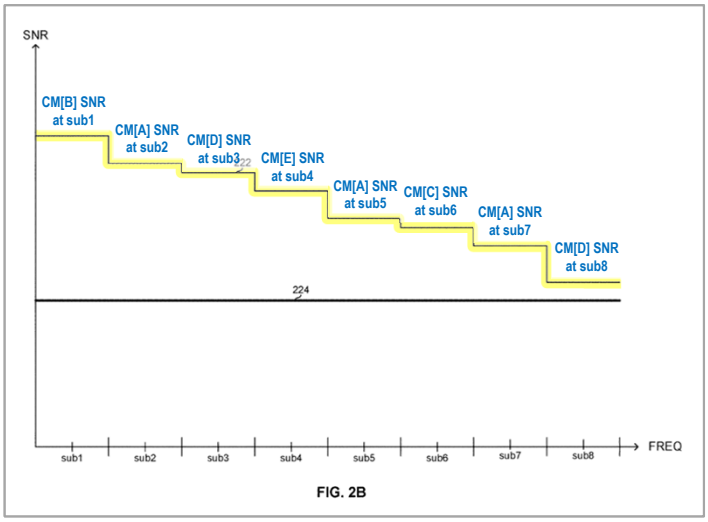

FIG. 2B

140

Thus, if a hypothetical service group had five cable modem in it, called cable modems A, B, C, D and E, the composite worst case SNR profile for that service group might look like our annotation of Figure 2B depicted on the right.

'682 PATENT: SERVICE GROUP ASSIGNMENTS

Composite Worst Case SNR Profile

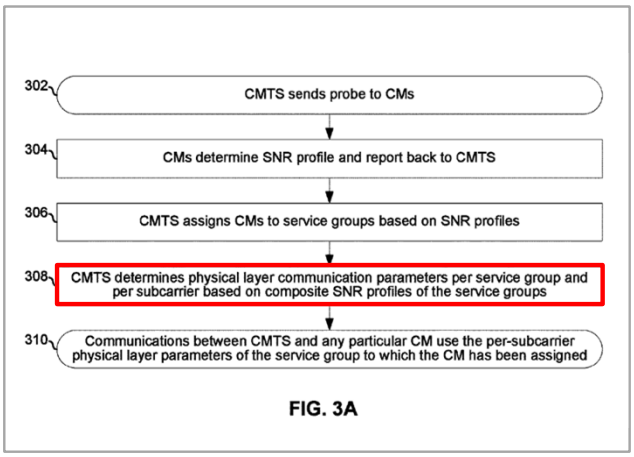

FIG. 3A

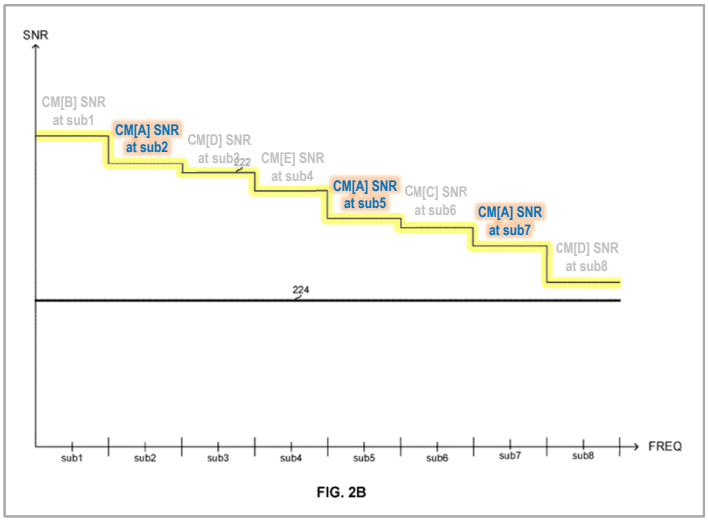

FIG. 2B

141

In this example, cable modem A has the worst SNR at subcarriers 2, 5 and 7.

'682 PATENT: SERVICE GROUP ASSIGNMENTS

Composite Worst Case SNR Profile

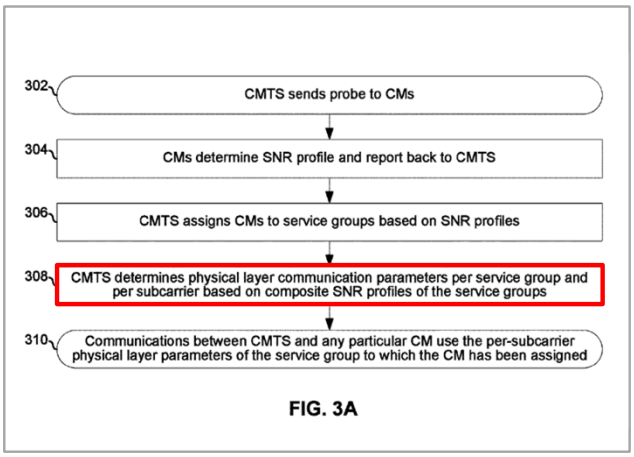

FIG. 3A

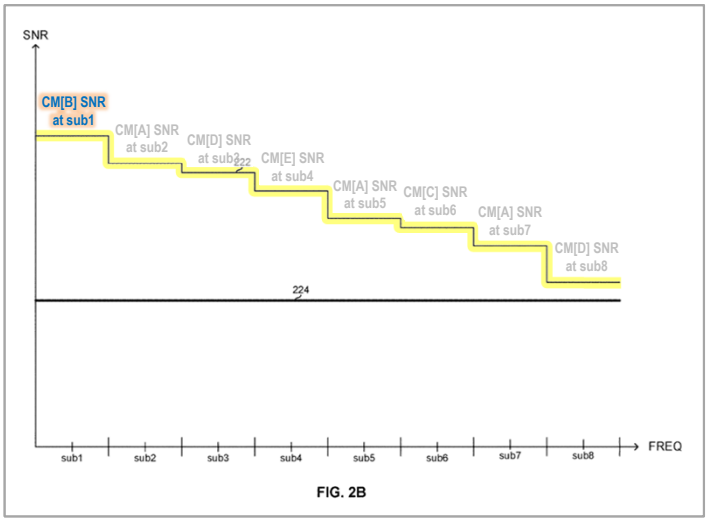

FIG. 2B

142

Cable modem B has the worst SNR at subcarrier 1.

'682 PATENT: SERVICE GROUP ASSIGNMENTS

Composite Worst Case SNR Profile

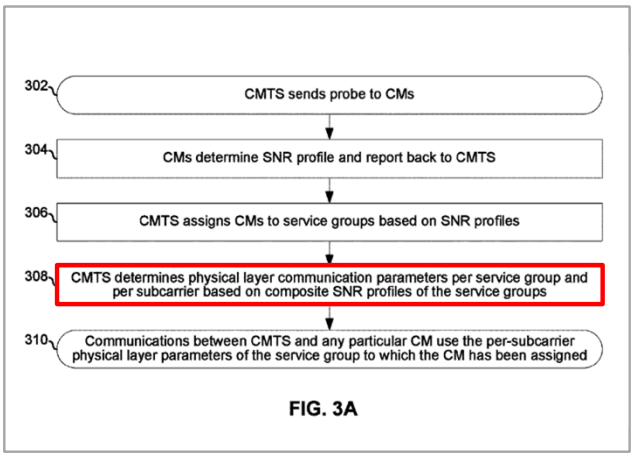

FIG. 3A

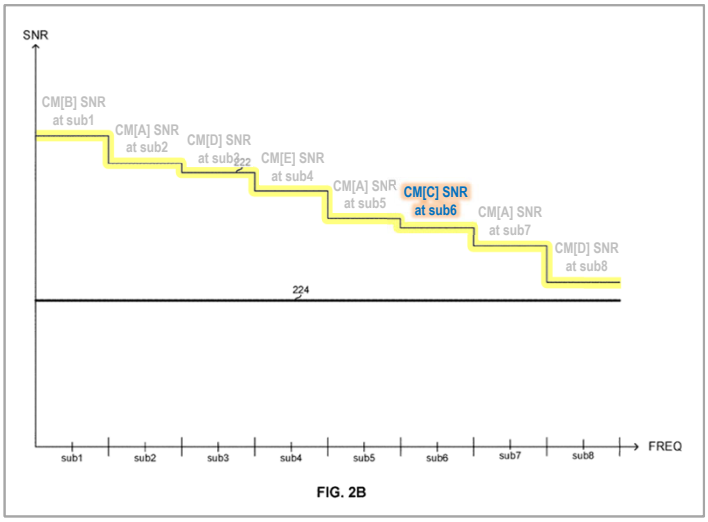

FIG. 2B

143

Cable modem C has the worst SNR at subcarrier 6.

'682 PATENT: SERVICE GROUP ASSIGNMENTS

Composite Worst Case SNR Profile

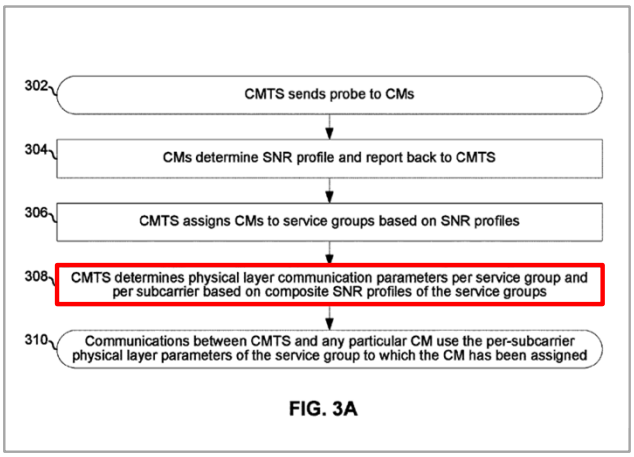

FIG. 3A

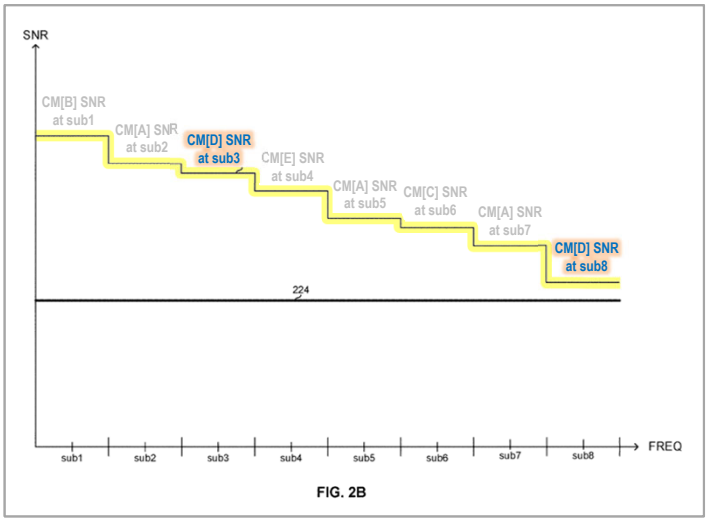

FIG. 2B

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cable modem D has the worst SNR at subcarriers 3 and 8.

'682 PATENT: SERVICE GROUP ASSIGNMENTS

Composite Worst Case SNR Profile

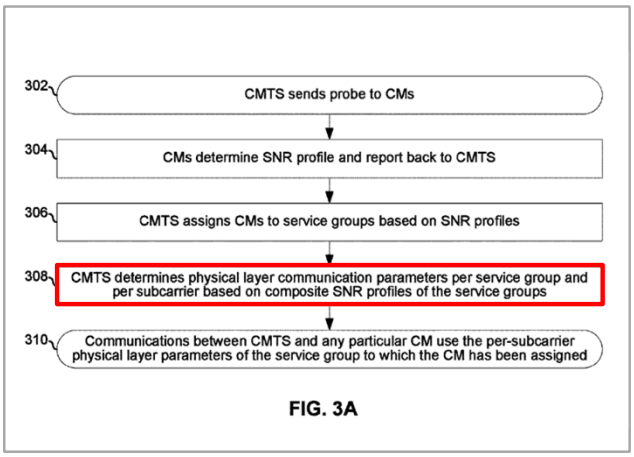

FIG. 3A

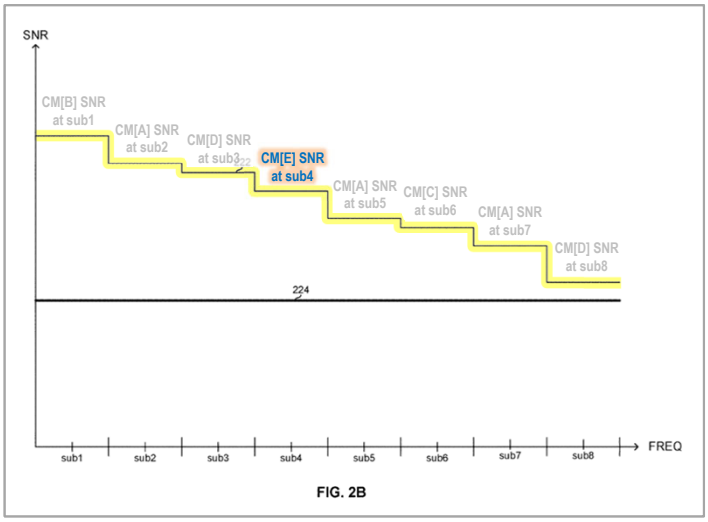

FIG. 2B

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And cable modem E has the worst SNR at subcarrier 4.

'682 PATENT: SERVICE GROUP ASSIGNMENTS

Communications with Cable Modems

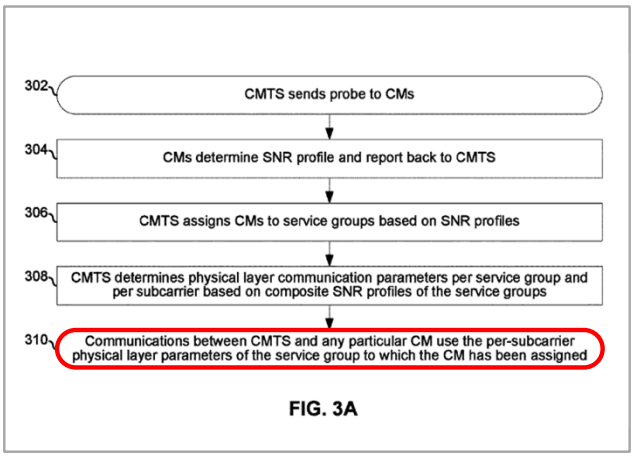

FIG. 3A

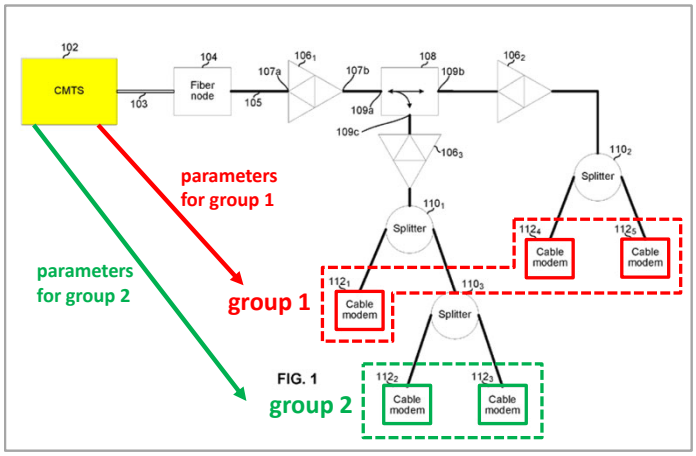

FIG. 1

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Finally, in step 310 of Figure 3A, the CMTS communicates with the cable modems in a service group using the parameters it determined in step 308.

That concludes our discussion of the 682 patent. Again, we will not address the claims of the 682 patent because Charter contends that those claims are indefinite and that it is not possible to understand what those claims cover.

The End

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And that also concludes Charter's technology tutorial. Thank you Your Honor for the opportunity to present it.